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Curriculum Guideline for the
Intermediate and Senior Divisions

Revised draft copy (1982 03 12)

ACKNOWLEDGEMENTS

The Ministry of Education wishes to acknowledge the contributions of the following persons who participated in the development of this guideline.

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INTRODUCTION

This guideline outlines Ministry of Education policy for the development of environmental science courses in the Intermediate and Senior Divisions in Ontario schools and, in addition, includes information that will assist teachers with course development and implementation.

PART A: DEVELOPMENT AND IMPLEMENTATION OF COURSES provides the pedagogical base for the development and implementation of meaningful courses in environmental science. It gives a rationale that outlines the role of environmental science in the school program and lists the aims of environmental science as they relate to the needs of students and society. It also describes the provisions and conditions for course development and discusses teaching strategies appropriate for the teaching of environmental science.

PART B: UNIT OUTLINES contains content summaries and suggested activities and resources for the units of study that are included in this guideline.

PART C: APPENDICES includes information on safety in the laboratory and field, guidelines for animal care, instructions for conducting attitude-behaviour studies, an annotated bibliography of selected books and journals and details concerning the sources of the resources listed in the unit outlines of Part B.

This document provides local curriculum planners with the information needed for the development of courses in environmental science from Grade 9 to Grade 12 for students at the advanced, general, and basic-modified levels.

This guideline replaces *Environmental Science, 73-74/3019* and *Agriculture RP21/1962*.

PART A: DEVELOPMENT AND IMPLEMENTATION OF COURSES

RATIONALE

Human beings, in their quest for an improved quality of life, have created a situation in which the "better life" masks a dangerous depletion of the very resources used to provide the "better life". Our commitment to economic development and growth, combined with the escalating needs of increasing numbers of people, have encouraged many people to take a short-sighted approach to the utilization of natural resources. The results of this approach are now quite apparent: loss of cropland, destruction of productive forests, soil erosion, water and air pollution and extinction of species, to name a few. Humans must come to terms with the fact that natural resources are limited and that ecosystems have limited carrying capacities. Further, we must always be mindful of the needs of future generations. In short, we must practice conservation. Humans engage in development to provide for social and economic welfare. The purpose of conservation is to ensure that the Earth can sustain that development and support all life.

Growth in productive capacity may be seen as beneficial when it improves the quality of life. However, growth becomes dangerous when it overwhelms an ecosystem's carrying capacity. For example, growth in agricultural productivity in a country seems desirable until the intensified agricultural practices permit the productivity of the land to overwhelm the soil's carrying capacity, with undesirable results such as soil erosion and changes in soil structure. Even growth of a community may seem advantageous. However, it is only advantageous until it reaches the point at which site crowding, population density and traffic congestion diminish the general welfare of the community.

The role of environmental science courses in our schools is to make students aware of the fact that an improved quality of life need not involve a commitment to material gain, growth and dominance of humans over the rest of nature. Instead, an improved quality of life can be achieved through practicing conservation - the ecologically sound management of productive ecosystems and the maintenance of their versatility and viability. Environmental science courses must provide students with a knowledge of basic ecological principles and, in addition, give them the skills required to apply that knowledge to the sound management and maintenance of the many ecosystems on which all life on Earth depends.

AIMS OF ENVIRONMENTAL SCIENCE

UNESCO Occasional Paper 31 (see Appendix C) gives the following statement for the overall goal of environmental education:

> *The goal of environmental education is to develop a population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.*

Environmental science is a part of environmental education. As such, it must contribute toward the achievement of this overall goal. To that end, every course developed from this document should provide students with opportunities to:

- acquire environmentally oriented social values, deep feelings of concern for the environment, and the motivation to become actively involved in the protection and improvement of the environment;
- develop an awareness of and a sensitivity to the total environment and its associated problems;
- acquire a basic understanding of the total environment, based on the ecosystem concept;
- understand environmental problems and the critically important roles of humans, both in the creation of many of these problems and in their solutions;
- acquire the skills required for solving environmental problems;
- develop sufficient sense of responsibility and urgency regarding environmental problems that they will become involved in appropriate action to solve those problems;
- evaluate environmental measures, industrial and commercial projects, governmental policies and environmentally oriented writings in terms of ecological, social, political, economic, aesthetic, and educational parameters;

- acquire the knowledge and skills required for further education and/or employment in environmentally related fields.

To meet the overall goal of environmental education, an environmental education course should be designed to provide opportunities for students to:

- consider the environment in its totality - natural and human-made, ecological, cultural, aesthetic, economic, political, social, technological, and legislative;
- experience an interdisciplinary approach to the study of environmental science;
- participate in solving and preventing environmental problems;
- focus on current and future environmental situations;
- examine growth and development from an ecological perspective;
- develop an awareness that environmental education is a continuous life-long process;
- examine appropriate environmental issues from a world point of view;
- develop an understanding of the value and necessity of local, provincial, national and international cooperation in the solving of environmental problems;
- develop the attitudes, knowledge, and skills required for participation in the solving of local and regional problems;
- develop an understanding of the knowledge and skills required to engage in further education and/or employment in a variety of environmentally related fields;
- gather knowledge about the environment by *first-order methods* such as field trips, laboratory exercises, and empirically oriented projects;
- gather knowledge about the environment by *second-order methods* such as library research;
- participate in the process of scientific inquiry and develop positive attitudes towards the scientific endeavour (see Intermediate Division Science, 1978, pages 5-7);
- develop reading and communicative skills.

COURSES FOR GRADES 7 AND 8

Though this guideline is applicable to both the Intermediate and Senior Divisions, it provides no course outlines for Grades 7 and 8. The Intermediate Science and Intermediate Geography courses provide sufficient environmental education for students in those grades.

The guideline *Intermediate Division Science, 1978* provides opportunities to put an environmental focus on courses developed from that guideline. It contains a core unit, *Interdependence of Living Things,* which offers a sound introduction to basic ecological principles. Also, several optional units from the guideline are environmentally oriented:

E7 *Adaptation and Behaviour*
E9 *Forestry Resources*

E14 *Mining Resources*
E16 *Rocks and Minerals*
E19 *Water*
E20 *Weather*
E21 *Wise Use of Energy*

Finally, all or some of the Locally Designed Units of *Intermediate Division Science, 1978* could deal with environmental science.

Environmental science is an integral part of *Intermediate Geography, 1977.* Among the topics that provide an environmental focus are:

Population Patterns
Locality Studies
Our Natural Heritage
Agriculture
The Industrial Giant
Weather
Fragile Environments
Modifying the Environment
Urbanization

The environmental focus of the Grade 7 and 8 science and geography courses can be enhanced by the integration of the appropriate sections of the science and geography courses. For example, *Forestry Resources* from *Intermediate Science, 1978* could be integrated with *Our Natural Heritage* from *Intermediate Geography, 1977.* In this way needless overlap is avoided and an interdisciplinary approach to environmental science is facilitated. This guideline could be used as a resource in the development of such integrated units.

COURSES FOR GRADES 9 to 12: GENERAL DESCRIPTION

This guideline provides material for the development of courses in environmental science from Grades 9 to 12 for students at the advanced, general, and basic levels.

> *NOTE:: The vocabulary used in the titles of the units of study (see page 00) and in the content summaries for those units (see Part B, pages 00 to 00) is teacher-oriented. Its function is to indicate clearly the ideas, concepts, and principles that should be taught. The same vocabulary need not be used with students. It is the responsibility of local curriculum planners to choose vocabulary and a level of content sophistication that is appropriate to the level of difficulty for which a course is being designed.*

Number of Courses

The staff of a school, with the approval of the board, may develop a curriculum in environmental science consisting of one, two, three, or four full year courses in the Grade 9 to 12 continuum at any or all of the advanced, general, and basic levels.

Number of Hours Per Course

Each full year course shall consist of a minimum of 120 h of scheduled time for credit purposes. With the successful completion of each full year course, the student shall be granted 4 credits.

Planning an Interdisciplinary Course

The nature of the subject matter of environmental science dictates that courses developed from this guideline should have an interdisciplinary flavour. For most topics, the main disciplines involved are geography and science. The following suggestions should facilitate the development of courses that draw from the content and methodology of geography and science while avoiding undue overlap with established courses in those disciplines.

- Courses could be developed as a cooperative effort between the science and geography departments in a school.

- Teachers who are planning courses in environmental science should maintain a close liason with both the science and geography departments to ensure that overlap with other courses is kept to a minimum and to obtain advice on ways of maximizing the interdisciplinary nature of the courses.

- Team teaching by science and geography teachers could be employed.

Employment Opportunities

The knowledge and skills gained from courses offered under this guideline can prepare students for further education and/or employment in a wide variety of environmentally related fields such as agriculture, ecology, forestry, horticulture, landscaping, animal science, plant science, soil science, and wildlife biology.

Where appropriate, students should be informed of employment opportunities that can arise directly from the successful completion of the course or courses being offered. Further, students should be counselled regarding college and university courses that are available for those wishing to undertake additional studies in any environmentally related field.

COURSES AT THE ADVANCED LEVEL

Advanced-level courses are to be designed on the basis of the following guidelines:

- Each course will consist of at least *eight* (8) units. Each unit will be about 15 h in duration.

- Each course will consist of *five* (5) mandatory core units and at least *three* (3) optional units.

- The optional units should be selected on the basis of the needs, abilities, and interests of the students for whom the course is being designed.

- The vocabulary used in the titles of the units of study and in the content summaries for those units (see Part B) is teacher-oriented. Its function is to indicate clearly the ideas, concepts and principles that should be taught. The same vocabulary need not be used with students. It is the responsibility of local curriculum palnners to choose vocabulary and a level of content sophistication that are appropriate to the abilities of the students for whom a course is being designed.

- The time allotments given in the unit outlines of Part B are approximate and may be altered to accommodate the needs, interests, and abilities of the students.

- Topics within a unit may be omitted if they have been adequately covered in previous courses.

- The activities and resources listed in the unit outlines of Part B are suggestions only; they are not prescriptive. Normally, time will not permit the utilization of all the activities and resources given in a unit outline. *Under no circumstances, however, should activities be ignored to permit a more detailed treatment of the content.* Environmental science courses must be activity-oriented.

- The units of study are to be selected in accordance with the descriptions that follow:

UNITS OF STUDY

UNITS OF STUDY FOR A FOUR-YEAR CURRICULUM

Follow these guidelines if a course is to be offered in *each year* of the Grade 9 to Grade 12 continuum. At least *eight* (8) units are required for a full year course.

CORE UNITS

Five (5) units are mandatory at each grade level.

GRADE 9	GRADE 10
9.1 Population and Community Ecology	10.1 Terrestrial Ecosystems
9.2 Introduction to Soil and Plant Science	10.2 Animal Science
9.3 Agricultural Systems	10.3 Plant Science I
9.4 Energy I	10.4 Energy II
9.5 Humans in the Environment I	10.5 Humans in the Environment II

GRADE 11	GRADE 12
11.1 Aquatic Ecosystems	12.1 Pesticides in the Environment
11.2 Air Quality	12.2 Land Use
11.3 Plant Science II	12.3 Plant Science III
11.4 Energy III	12.4 Energy IV
11.5 Humans in the Environment III	12.5 Humans in the Environment IV

OPTIONAL UNITS

Select a minimum of *three* (3) units for *each year* of the curriculum. These units may be selected from any or all of Groups A, B, and C.

Group A Four-Unit Blocks

The units in this group are in four-unit blocks. They should be taught in the sequence indicated by the Roman numerals, but all four units need not be taught. For example, you may teach just Domestic Animals I of the Domestic Animal block of units.

A four-unit block need not be taught as one unit per year for four years. It may be taught as two units per year for two years or as four units in one year. In the latter case, this block of units will use up all the optional unit time. In fact, four units will have to be taught in the time interval allotted for three units. This can be accomplished by exercising selectivity in the choice and treatment of topics.

A.1 Domestic Animals I	A.2 Domestic Animals II	A.3 Domestic Animals III	A.4 Domestic Animals IV
A.5 Horticulture I	A.6 Horticulture II	A.7 Horticulture III	A.8 Horticulture IV
A.9 Landscaping I	A.10 Landscaping II	A.11 Landscaping III	A.12 Landscaping IV

Group B Two-Unit Blocks

The units in this group are in two-unit blocks. They should be taught in the sequence indicated by the Roman numerals, but the first unit may be taught without teaching the second. The two units of a block may be taught in any two consecutive years or both in one year.

B.1 Agribusiness I	B.2 Agribusiness II
B.3 Agricultural Crop Science I	B.4 Agricultural Crop Science II
B.5 Agricultural Engineering I	B.6 Agricultural Engineering II
B.7 Forestry I	B.8 Forestry II
B.9 Microbiology I	B.10 Microbiology II

Group C Single Units

Units marked with an asterisk (*) are most suitable for Grades 11 and 12. The others may be taught at any grade level. Consult with the science and geography departments when selecting units from this group in order to avoid overlap with existing science and geography courses. Also, plan ahead. If, for example, considerable field work is planned for the "Terrestrial Ecosystems" unit of Grade 10, it might be wise to select "Diversity and Classification of Organisms" as an optional unit in Grade 9.

C.1 Differential Levelling*
C.2 Diversity and Classification of Organisms
C.3 Domestic Wastes
C.4 Energy and Agriculture
C.5 Environmental Law*
C.6 Human Population Ecology*
C.7 Indoor Gardening
C.8 Life Cycles
C.9 Mineral Resources and Mining
C.10 Natural Gardening and Farming
C.11 Noise Pollution
C.12 Ontario Northern Environment
C.13 Plant Diseases and Pests
C.14 Rocks and Minerals
C.15 Soil Ecology
C.16 Soil Science
C.17 The Atmosphere, Weather and Climate
C.18 Urban Forestry
C.19 Wildlife Biology
C.20 Locally Designed Unit

UNITS OF STUDY FOR A ONE-YEAR CURRICULUM

Follow these guidelines if a course is to be offered for *one year* in the Grade 9 to 12 continuum. At least *eight* (8) units are required for a full year course.

CORE UNITS

Five (5) units are mandatory.

1. Energy

   Design a 15 h unit using the content of Energy I, II, III and IV.

2. Humans in the Environment

   Design a 15 h unit using the content of Humans in the Environment I, II, III and IV.

3. *One* of Terrestrial Ecosystems or Aquatic Ecosystems.

4. *One* of Introduction to Soil and Plant Science, Agricultural Systems, Animal Science or Plant Science (a combination of Plant Science I, II and III).

5. *One* further unit selected from the core units of the four-year curriculum.

OPTIONAL UNITS

Select a minimum of *three* (3) units from the remaining core units and the optional units of the four-year curriculum.

UNITS OF STUDY FOR A TWO-YEAR CURRICULUM

Follow these guidelines if a course is to be offered in each of *two years* in the Grade 9 to 12 continuum. At least *eight* (8) units are required for a full year course.

CORE UNITS

Five (5) units are mandatory for *each year* of this curriculum.

1. Energy

   Design a 15 h unit for *each year*, using the content of Energy I, II, III and IV.

2. Humans in the Environment

   Design a 15 h unit for *each year*, using the content of Humans in the Environment I, II, III and IV.

3. *One* of Terrestrial Ecosystems, Aquatic Ecosystems or Agricultural Systems in *each year*.

4. *One* of Introduction to Soil and Plant Science, Agricultural Systems, Animal Science or Plant Science (a combination of Plant Science I, II and III) in *each year*.

5. *One* further unit for *each year* selected from the core units of the four-year curriculum.

OPTIONAL UNITS

Select a minimum of *three* (3) units from the remaining core units and optional units of the four-year curriculum for *each year*.

UNITS OF STUDY FOR A THREE-YEAR CURRICULUM

Follow these guidelines if a course is to be offered in each of *three years* in the Grade 9 to 12 continuum. At least *eight* (8) units are required for a full year course.

CORE UNITS

Five (5) units are mandatory for *each year* of this curriculum.

1. Energy

   Design a 15 h unit for *each year*, using the content of Energy I, II, III and IV.

2. Humans in the Environment

   Design a 15 h unit for *each year*, using the content of Humans in the Environment I, II, III and IV.

3. *One* of Terrestrial Ecosystems, Aquatic Ecosystems or Agricultural Systems in *each year*.

4. *Two* further units for *each year*, selected from the core units of the four-year curriculum.

OPTIONAL UNITS

Select a minimum of *three* (3) units from the remaining core units and the optional units of the four-year curriculum for *each year*.

COURSES AT THE GENERAL LEVEL

General-level courses are to be designed on the basis of the following guidelines:

- Each course will consist of at least *eight* (8) units. Each unit will be about 15 h in duration.

- Each course will consist of *five* (5) mandatory core units and at least *three* (3) optional units.

- The optional units should be selected on the basis of the needs, abilities, and interests of the students for whom the course is being designed.

- The units of study are to be selected in accordance with the descriptions given on pages 00 to 00 for advanced-level courses.

- In most instances the vocabulary used in the titles of the units of study and in the content summaries for those units (see Part B) is *not* suitable for use with general-level courses. Its function is merely to indicate the ideas, concepts and principles that should be taught. It is the responsibility of local curriculum planners to choose vocabulary and a level of content sophistication that are appropriate to the abilities of the students for whom the course is being designed.

- Though a general-level course will have the same core units as the corresponding advanced-level course, the general-level course *should differ substantially* from the advanced-level course. In comparison to the advanced-level course, the general-level course should exhibit these features:

  a) a reduction in the use of scientific and technical vocabulary;

  b) an increased emphasis on the practical applications of the course material;

  c) a reduction in the number of topics included in a unit, this reduction being achieved by the deletion of the more theoretical topics and topics that may be of little immediate relevance to the students;

  d) an increase in the time spent on the remaining topics in a unit;

  e) an increase in the number of activities;

  f) the inclusion of optional units that emphasize skills development and practical applications.

COURSES AT THE BASIC LEVEL

Courses at the basic level are to be designed on the basis of the following

- Each course will consist of at least *six* (6) units. Each unit will be about 20 h in duration.

- At least *four* (4) of the units of study for each course are to be selected from those listed on pages 00 to 00 for advanced-level students. Up to *two* (2) units may be designed locally.

- The "Core Units" are *not* mandatory, and the selection of units may be made with great flexibility provided the selection produces courses that meet the needs, abilities, and interests of the students and provided the courses follow the general intent of this guideline - to provide a grounding in the fundamentals of environmental science.

- For most courses at the basic level it is appropriate to include one or two units that provide basic knowledge about environmental science. Examples are *Population and Community Ecology* and *Agricultural Systems*. The titles and content of the units will, of course, be adapted in language, content sophistication and approach to the abilities of the students. Further, the material should be presented primarily through an activity-centred approach.

- Most of the units for a course should be selected from those which place an emphasis on skills development and which, as a result, can be taught primarily through hands-on activities. Examples are *Horticulture, Landscaping, Agricultural Crop Science, Indoor Gardening, Natural Gardening and Farming,* and *Forestry*.

- Locally designed units will normally be created by putting together material selected from the unit outlines in Part B of this guideline. For example, an energy unit could be created by putting together material selected from *Energy I, Energy II, Energy III,* and *Energy IV,* with care being taken to select material that will be of interest and of practical value to the students. Home insulation, conservation of electrical energy, conservation of gasoline, and solar heating are examples.

- Schools with greenhouses may wish to build full courses around the *Horticulture* and *Landscaping* units.

- Schools in agricultural areas may wish to build full courses around agriculturally oriented units such as *Agricultural Crop Science* and *Agricultural Engineering*.

- A course at the basic level *should differ substantially* from a general-level course for the same grade. In comparison to the general-level course, the basic level course should exhibit these features:

  a) a much greater emphasis on practical applications;

  b) an increased reliance on an activity-centred approach;

  c) an increased emphasis on skills development;

  d) a considerable reduction in the breadth and depth of treatment of the topics;

  e) a much simplified language.

PROGRAMS FOR EXCEPTIONAL STUDENTS

Every consideration must be given to the exceptional student, whether the exceptionality is intellectual, behavioural, physical, communicative, or a multiple handicap. Once a student has been identified as exceptional by the Identification, Placement, and Review Committee of a school, the committee should suggest the appropriate placement of the student in a course. Then it becomes the responsibility of the teacher and the IPR committee, with assistance from the Special Education department, to accommodate the exceptionality of the student.

It is important to bear in mind that courses at the basic level are not exclusively for the placement of exceptional students. Further, not all exceptional students will be placed in that level. A student who is intellectually gifted would be placed in an advanced-level course and the IPR committee would ensure that this student receives a challenging and worthwhile education through additional experiences such as enrichment activities and independent studies that require a high degree of problem-solving skill and the utilization of research methods.

A student with an intellectual problem that makes learning difficult should not be placed automatically in a "basic-level program" in which the student takes all courses at the basic level. It is possible that this student can cope with some courses at, for example, the general level and others at the basic level.

Environmental science courses, with their emphasis on an activity-centred approach to the study of practical and current topics, offer unique opportunities to accommodate the needs, interests, and abilities of most exceptional students. Students with physical handicaps will, of course, be given individual consideration. For example, a student with reduced manual dexterity should not be expected to match the psychomotor performance of his/her peers in activity-oriented aspects of the course, nor should this student be put in the position of simply being a passive observer of his/her peers' activities. Instead, this student should be provided with alternative learning tasks that will prove to be personally satisfying and enriching.

EVALUATION

Purpose

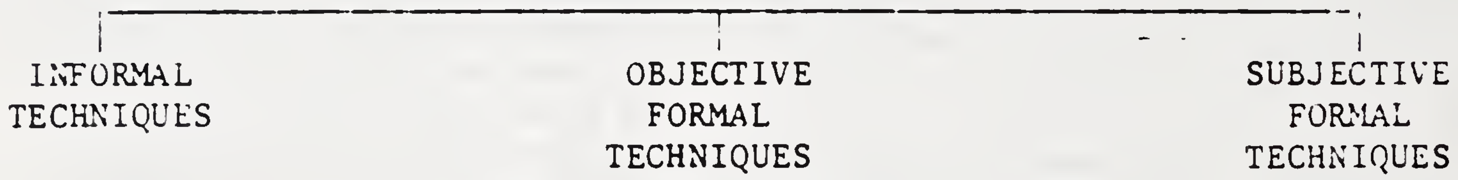
Evaluation of student achievement and program effectiveness is one of the most important aspects of the total education process. Thus it follows that evaluation should be an integral and ongoing part of the teaching-learning process. As such, it can serve the following functions:

- to assist the teacher in planning instruction (through the use of formative evaluation instruments such as topic and unit pre-tests);
- to provide students with diagnostic information on their progress (through the use of continuous feedback data such as that obtained from short daily or weekly quizes);
- to determine the degree of student growth, that is, the extent to which the student has attained the course objectives (through summative evaluation instruments such as achievement tests);
- to provide the teacher with feedback on the effectiveness of his/her teaching strategies, curriculum, and objectives;
- to encourage diligent study;
- to assist the teacher with future course planning by revealing strong and weak areas in the curriculum.

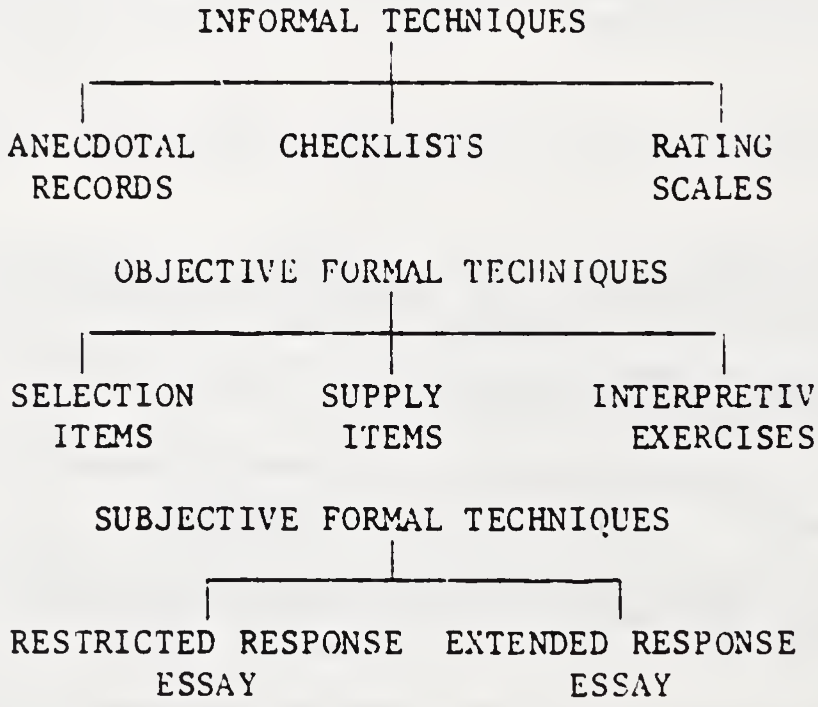
Evaluation Techniques

Because the information gained through evaluation is used to assess most aspects of the teaching-learning process, it is necessary to gather the information from a wide variety of sources. Accordingly, the teacher should use a wide range of techniques to evaluate the student's achievement - in the affective and psychomotor domains as well as in the cognitive domain.

Most of the evaluation techniques available to the teacher can be grouped into three categories according to the degree of student involvement in the response. (A "formal" test item is one that uses paper and pencil.)



These categories may be further divided into the types of evaluative instruments found in each category.



Other evaluation techniques that should be considered by the teacher are teacher observation, student-teacher interviews, projects, peer evaluation, self-evaluation, and oral tests. In some instances these techniques will be combined with those shown in the flow chart above. For example, the results of a teacher observation session could be summarized in an anecdotal record or on a checklist. A student could be given a rating scale to guide his/her self-evaluation. A project could be marked using a rating scale.

Consult the Ministry of Education document *Evaluation of Student Achievement, 1976* for further information on evaluation.

Selected Appropriate Evaluation Techniques

A wide variety of evaluation techniques should normally be used with all students. However, the unit objectives, the grade and level (advanced, general, basic)and individual student exceptionalities will determine the proportion of items of each type that are used in evaluation. The following examples illustrate this point:

- An intellectually gifted student could have a higher than average percentage of the total evaluation derived from projects, problem-solving assignments, extended response essay items such as reports on library research undertakings.
- A student in a course at the basic level would normally have a low percentage of the total evaluation derived from formal evaluation techniques and a high percentage derived from informal techniques such as practical tests, teacher observation and the use of checklists designed to evaluate performance during field and laboratory activities.
- If the objectives for a unit focus on skills development, the evaluation techniques employed should also be skills-oriented. Thus practical tests, performance checklists, and rating scales could be the main evaluation technique used to evaluate student achievement in units such as *Horticulture*, *Landscaping*, and *Indoor Gardening*. The same techniques should also be used to evaluate the activity-centred portions of most other units in the course.
- For some exceptional students it may be necessary to depart from the desired diversity in evaluation techniques. For example, a student with a handicap that inhibits psychomotor performance may have to be evaluated largely through oral tests.

COPING WITH ETHICS, VALUES AND ATTITUDES

An environmental science course has achieved little if it fails to develop in students a personal environmental ethic related to environmental, economic and social issues. However, the teacher must be careful not to impose on students his/her own personal set of values and attitudes. The teacher's role is to provide students with a balanced set of experiences that will assist the students with the formation of ethical values and attitudes.

An Appropriate Environmental Ethic

In order to be able to select, organize and offer experiences to students that will assist them with the development of their personal environmental ethics, the teacher must possess a clear idea of what constitutes a reasoned, defensible and appropriate environmental ethic for today's and tomorrow's world. The following discussion should assist the teacher with the formulation of some basic ideas on this matter.

One possibility is an ethic that is based on the premise that what is good for nature is good for humans. An ethic based on this premise is arrived at by means of the human-centred path of self-interest, or self-survival, and, perhaps, the path of human survival. Such an ethic is based on an understanding and acceptance of the ecosystem concept and our place in the ecosystem. This may be the workable ethic to pursue.

There are many other paths that may ultimately lead to the same environmental ethic as does the path of self-interest. Among these are the following:

- respect for all living things;
- appreciation of the beauty of nature.

Ideas for Developing Values and Attitudes

Values and attitudes cannot be developed through a few lectures on environmental ethics. Instead, the teacher should view the development of values and attitudes as a long-term goal of the school's program in environmental science that is to be gradually approached through everything that is done in the program. The following ideas should help achieve that goal:

- An appropriate environmental ethic should underlie and permeate every environmental science course.
- This ethic should permeate all units of the course.
- Students should be given opportunities to examine perspectives, arrive at value positions, then articulate and express in writing statements of their personal environmental ethics, particularly during the teaching of the *Humans in the Environment* units.
- Students should be encouraged to analyze environmental problems and proposed environmental projects in terms of their own environmental ethics.
- Students should be given opportunities to develop and use decision-making skills in order that they will develop confidence in their abilities to apply their environmental ethics to the decision-making process with decisiveness and effectiveness. These skills may be developed through such activities as debates, the writing of papers on controversial issues, the writing of analytical and evaluative papers on collections of newspaper articles relating to environmental issues, the seeking of first-order information through activities such as field trips and laboratory exercises, the seeking of second-order information through library research and attendance at lectures on environmental matters, and participation in group projects such as recycling projects and community action groups.

A Scheme for Dealing with Issues

During some units of the course controversial issues will have to be discussed by the class. Some examples are sports hunting, logging in provincial parks, smoking in public places, noise in residential neighbourhoods and the use of pesticides. An important objective of the course should be to prepare students to cope with the discussion of such issues. However, care must be taken to avoid non-productive confrontation such as arguments that are based on uninformed opinion and emotions only. Also, the teacher must avoid being placed in a situation where he/she can be accused of forcing his/her attitudes on the students. The following scheme should help the teacher avoid these potential problems.

1. Define the issue and set the limits for the discussion. Make it clear to the class that diversions from the issue will not be allowed during the discussion.

2. Establish the required background knowledge in order that the student can recognize and sort out factual and emotional arguments. Films, speakers and articles from newspapers, magazines and books should augment the input of the teacher.

3. Conduct an attitude-behaviour study to sample the opinions of the community on the issue. Appendix C describes how to conduct such a study.

4. Conduct any experiments that may be appropriate.

5. Examine the legal aspects of the issue.

6. Conduct a discussion or debate on the issue. You may wish to follow this by asking each student to submit a personal opinion, supported by facts and logical arguments, in essay form.

7. Develop an action strategy, that is, a list of things the students can do to help resolve the issue on a societal level.

PART B: UNIT OUTLINES

IMPORTANT NOTES

1. The vocabulary used in the unit titles and content summaries is teacher-oriented. Its function is to indicate clearly the ideas, concepts and principles that should be taught. The same vocabulary need not be used with students.

2. The time allotments given for the topics are approximate and may be altered to accommodate the backgrounds, needs, interests and abilities of the students.

3. The activities and resources are suggestions only; they are not prescriptive. Normally, time will not permit the utilization of all the activities and resources given in a unit outline. Consult Appendix D for sources of information on content, resources and activities.

4. Consult pages 00 to 00 for descriptions of the procedures to be used in the selection and adaptation of these units for courses at the advanced, general, and basic levels.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 9.1 POPULATION AND COMMUNITY ECOLOGY	

UNIT OUTLINES

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 9.1 POPULATION AND COMMUNITY ECOLOGY	
An environmental science course must be built upon well established ecological principles. This unit outlines those principles. Many of the same principles are dealt with in Intermediate Science. Therefore your objective should be to reinforce and extend the students' knowledge of these principles without undue repetition of the basic content. You can best achieve this objective by quickly reviewing content covered in earlier years, using non-traditional examples for your illustrative material. For example, you could replace the traditional *grass* → *mouse* → *fox* food chain with a food chain from Canadian agriculture.	
1. Ecology and Levels of Biological Organization (1.0 h) *individual, species, population, community, biome, biosphere, ecology.*	FILM: What is Ecology? 2nd Edition (EBE)*
2. The Ecosystem Concept (1.0 h) *ecosystem, biotic, abiotic, role of the ecosystem concept as an "organizer" for ecological studies.*	FILM: The Community (EBE) FILMSTRIP: What is Ecology? (PH) FILMSTRIP: Populations, Communities & Biomes (S & M
3. Structure of an Ecosystem (3.0 h) *habitat, niche, trophic level, producer, autotroph, consumer, herbivore, carnivore, heterotroph, decomposer, omnivore, prey, predator, scavenger, food chain, food web, pyramids of numbers, biomass and energy, symbiosis, parasitism, host, parasite, mutualism, commensalism, range of tolerance.*	ACTIVITY: Investigate the schoolyard as an ecosystem. ACTIVITY: Build a mini-ecosystem (closed bottle). FILMSTRIP: Ecology: The Living Web (A&B)
4. Energy Flow in Ecosystems (1.5 h) *the sun as the ultimate source of energy, energy loss along food chains, dependence of humans on the flow of energy, manipulation of forest and agricultural ecosystems to maximize the flow of energy to humans.*	FILMSTRIP: Matter, Energy, and Ecosystems (S&M)
5. Nutrient Cycles in Ecosystems (2.0 h) *water cycle, carbon cycle, nitrogen cycle, phosphorus cycle (optional), the concepts of nutrient and nutrient cycle, importance of these concepts in home gardening, lawn maintenance, and agriculture.*	ACTIVITY: Addition of nutrients to classroom aquatic ecosystems. *See Appendix E for the meanings of the letters after the resources.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Ecological Succession (2.0 h) *primary succession on sand and/or rocks, secondary succession, hetertrophic succession (e.g., fallen log), pioneer species, index organism, dominant species, climax community.*	FILM: Succession - From Sand Dune to Forest (EBE) FILMSTRIP: Succession: Changes Through Time (A&B) ACTIVITY: Field trip to a local greenspace to study succession (primary, secondary, and heterotrophic).
7. Population Growth and Regulation (1.5 h) *a brief introduction to population dynamics, population size, population density, biotic potential, environmental resistance, population growth, sigmoid curve, birth rate, death rate, carrying capacity, interspecific and intraspecific competition.*	FILM: Population Ecology (EBE) ACTIVITY: A case study involving the analysis of population data.
8. Review and Evaluation (2.0 h)	

UNIT 9.2 INTRODUCTION TO SOIL AND PLANT SCIENCE

This unit consists of a "hands-on" introduction to the nature of soil and its role in the growth of plants. Its functions are to create interest in both soil and plant science and to provide your students with knowledge that will be of value to them if they become involved in growing plants indoors, maintaining lawns and gardens, and farming.

In-depth explanations and theoretical discussions are not a part of this unit. You should not, at this time, deal with soil formation, soil profiles, and the zonal classification system for soils. These topics are covered in Unit C.16. Also, do not explain nutrient uptake or plant growth and regulation. These topics are dealt with in Plant Science I, II, and III.

This unit is best taught after Unit 9.1 has been taught.

1. What is Soil (2.5 h) *mineral component, organic component, air component, living component, importance of soil.*	ACTIVITY: Determination of Soil water content. ACTIVITY: Determination of Soil water holding capacity. ACTIVITY: Determination of Soil organic content.
2. Four Closely Related Abiotic Properties of Soil (1.5 h) *particle size, porosity, capillarity, percolation rate.*	ACTIVITY: Determination of particle size with soil sieves or by sedimentation. ACTIVITY: A study of capillarity.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
	ACTIVITY: Determination of percolation rate at various sites in the school yard.
3. Soil Classification Based on Texture (1.0 h) *clay, loam, sandy loam, loamy sand, sand, triangular texture diagram.*	ACTIVITY: Determination of soil texture.
4. Some Biotic Properties of Soil (1.0 h) *a brief survey of the main categories of soil organisms: annelids, nematodes, molluscs, arthropods, protozoans, fungi, bacteria, and actinomycetes.* *Note: Unit C.15 covers this topic thoroughly.*	FILM: The World at Your Feet (NFB)
5. Soil as an Ecosystem (1.0 h) *biotic-abiotic interactions, energy flow in the soil, nutrient cycling. Extend the concepts introduced in Unit 9.1.*	
6. Soil as a Medium for Plant Growth (2.5 h) *provision of anchorage, water, air, macronutrients, micronutrients; importance of texture, organic content, pH, and other soil properties.*	ACTIVITY: Growth of plants from seeds to maturity. ACTIVITY: Growth of plants from cuttings to maturity.
7. Basic Requirements for Plant Growth (2.0 h) *air, water, light, suitable medium (see #6).*	ACTIVITY: Transplanting of seedlings.
8. Soil Conservation (1.5 h) *importance of plants in soil development and stabilization; causes of erosion; preventing erosion.*	FILMSTRIP: Soil: Its Meaning for Man (PH)
9. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 9.3 AGRICULTURAL SYSTEMS This unit is an introduction to Canadian agriculture. The primary focus is upon food production, with the emphasis placed upon the methods used to produce our food, the importance of those methods, and the attendant ecological and energy problems.	
1. Changing Agricultural Methods (1.0 h) *a brief history of agriculture in Canada, emphasizing the changes in farming methods, the reasons for those changes, and the overall effects (small family farms to large corporate operations, labour intensive to mechanization, diversification to specialization).*	FILM: Agriculture Canada (NFB) ACTIVITY: Development of a map of the main food producing regions of Canada through collective student contributions.
2. Agricultural Regions in Canada (1.0 h) *the main agricultural regions of Canada and their specialties; food producing regions of Ontario.*	ACTIVITY: Study and discussion of "Foodland Classification Map" in "Towards Reconciling Ontario's Future Needs for Food and Electricity" (Ontario Ministry of Agriculture and Food).
3. Energy Flow in Modern Agriculture (2.0 h) *comparison of the energy efficiency of traditional grass-hay beef production to modern feedlot beef production; dependency of modern methods on chemical fertilizers, mechanization, irrigation, and chemical pesticides; energy requirements for these processes; energy efficiency in food processing, packaging, and distribution.*	ACTIVITY: Study of "Energy and Agriculture" (Ontario Ministries of Energy and Agriculture and Food). ACTIVITY: Study and discussion of "Energy and Agriculture in Ontario" (Ontario Institute of Agrologists).
4. Chemical Fertilizers (1.0 h) *nutrient requirements of plants; types of fertilizers; sources of chemical fertilizers; application methods; importance; environmental problems from misuse; natural (organic) fertilizers.*	ACTIVITY: Study of labels from a variety of fertilizer bags. ACTIVITY: Growth of a food crop (e.g. tomato) from seed to maturity.
5. Mechanization in Agriculture (1.0 h) *role of mechanization (tillage, planting, harvesting); benefits of mechanization; social and economic effects; effects on farmland; energy supply implications.*	ACTIVITY: Study of the structure, diversity and function of implements using implement catalogues.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Pesticide Use in Agriculture (1.5 h) *types of pesticides; application methods; role in agriculture (increased food production); health and environmental problems; alternative pest control methods.*	ACTIVITY: Study of selected sections of "Pesticides Safety Handbook" (Ontario Ministry of the Environment) and/or "Guide to Chemical Weed Control" (Ontario Ministry of the Environment).
7. Rural Land Use (1.5 h) *need for farmland; non-farm uses of farmland compatible with farming; non-farm uses of farmland that remove land from food production.*	ACTIVITY: Further study of "Foodland Classification Map" to identify food producing regions under threat of urbanization.
8. World Food Supply (1.5 h) *world food supplies and needs; farming methods in other countries; role of climate; political and economic barriers to food production; main food producing countries; overconsumption versus starvation; the "Green Revolution".*	ACTIVITY: Study and discussion of portions of "Foodland: Preservation or Starvation" (Ontario Institute of Agrologists). ACTIVITY: Study of "Food Land Guidelines (Ontario Ministry of Agric ture and food
9. Food for the Future (1.0 h) *approaches to increasing food production (create more farmland, protect farmland, irrigation, fertilizers, pest control, food from the sea); implications of these approaches.*	FILMSTRIP: Food: Will There be Enough? (PH) FILMSTRIP: Land: Uses and Values (PH)
10. Chemical Additives in Our Food (1.0 h) *values of additives; negative features.*	ACTIVITY: Study and evaluation of labels from a variety of foods.
11. Review and Evaluation (2 h)	FILM: A Chemical Feast (Marlin)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 9.4 ENERGY I This introductory unit on energy establishes the nature of energy by exploring its forms and characteristics. It then distinguishes between renewable and non-renewable sources of energy. The unit concludes with a consideration of energy consumption and related resources in Canada and in the world to draw attention to the diminishing supply of petroleum. Check with the science department and feeder schools before planning this unit in order to avoid needless overlap. Treat this unit as an overview for stimulating interest. Detailed treatments of the topics occur in subsequent energy units.	
1. The Meaning of Energy (1.0 h) *work, power, and energy (a descriptive treatment only).*	FILMSTRIP: Energy: Concepts and Conversions (PH)
2. The Main Forms of Energy (1.5 h) *kinetic, gravitational, elastic, chemical (including food energy), electrical, heat, radiant, sound, and nuclear.*	DEMONSTRATION: The main forms of energy.
3. Characteristics of Energy (1.5 h) *exists in many forms; transferable from one object to another; can be stored; can be converted from one form to another; is conserved (Law of Conservation of Energy); all forms eventually degrade to heat.*	ACTIVITY: Energy conversions in a pendulum. ACTIVITY: Identifying energy conversions in common machines and objects.
4. Nonrenewable Energy Sources (3.0 h) *an introductory survey only; conventional fossil fuels (coal, petroleum and natural gas) - their origin, uses and reserves; nonconventional fossil fuel sources (tar sands and shale rock) - reserves, extraction, environmental problems; nuclear fission - its nature, reserves and positive and negative features; nuclear fusion; generating electrical energy using heat energy (via fossil fuels and nuclear reactors).*	FILMSTRIP: Non-renewable Energy Sources (PH) ACTIVITY: Extracting the tar (petroleum) from tar sands.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Renewable Energy Sources (2.5 h) *an introductory survey only: trapping solar energy by means of reflectors, flat-plate collectors, photovoltaic cells and photosynthesis (biomass production); energy from moving water (rivers and tides); wind energy; geothermal energy; hydrogen as a fuel.*	FILMSTRIP: Renewable Energy Sources (PH) ACTIVITY: Making a simple flat-plate collector. SOUND-SLIDE: Challenge for Change (CREF)
6. Energy Consumption and Reserves (2.5 h) *Canadian and global consumption of conventional fossil fuels; life-spans of reserves; the alternatives (new sources and conservation); the petroleum crisis; life-style and energy consumption.*	SOUND-SLIDE: Critical Issues in Science and Society: The Great Energy Debate (S&M) ACTIVITY: Preparation of a scrapbook on energy issues and solutions.
7. Review and Evaluation (2.0 h)	

UNIT 9.5 HUMANS IN THE ENVIRONMENT I

Throughout all units of this course a major objective should be to foster positive attitudes towards the environment. This unit provides an opportunity for the student to formalize those attitudes into a personal environmental ethic that will, hopefully, guide him/her in decision-making situations.

Societal needs, wants, and traditions have shaped our current ethic which generally is based on the principles of dominance and progress. Students should discover how this ethic developed. Then they should analyze its effects on the environment and consider the need for a new ethic. See pages 00 to 00 for a discussion of an appropriate ethic.

1. Humans in the Web of Life (1.5 h) *the biosphere as a global ecosystem; humans in the earth's food chains and webs; humans as manipulators of ecosystems; human effects on the balance of nature and feedback effects on humans.*	SOUND-SLIDE: Biological Catastrophe: When Nature Becomes Unbalanced (S&M) ACTIVITY: Environmental Values Game (Environment Canada).
2. Human Characteristics (1.5 h) *unique features of humans; role of these features in shaping our relationships with other living things and our physical environment.*	ACTIVITY: Begin a collection of newspaper articles on an environmental issue such as the oil crisis, energy conservation, acid precipitation or pollution of the Great Lakes.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
3. The Ecology of Early Humans (1.5 h) *the niches, habitats, trophic levels and other ecological relationships of two or three of our early ancestors; formulation of a theory that describes our ancestors' perception of their relationships with their environments.*	
4. Changing Values and Attitudes (3.0 h) *impact of civilization on values and attitudes; impact of agricultural practices such as plant and animal husbandry; impact of the Industrial Revolution; the environmental ethic of dominance and progress that characterizes western civilizations; effects of this ethic on the biosphere.*	ACTIVITY: A survey of community attitudes and behaviours with respect to an environmental issue such as noise, energy conservation, or transit alternatives. ACTIVITY: The Pollution Game (PH)
5. Development of a New Environmental Ethic (2.5 h) *distinction between wants and needs; basic needs of humans; some wants that create environmental problems; an ethic based on a respect for all forms of life and an understanding of the ecosystem concept.*	ACTIVITY: Reading of the short story "The Ugly Little Boy" from the book "Tomorrow's Children", Isaac Asimov (editor), Doubleday Co
6. Applying the New Environmental Ethic (2.0 h) *a look at some global environmental problems in the light of the new ethic: endangered species; water and air pollution; resource depletion; nutrition problems; conflict.*	ACTIVITY: The Planet Management Game (HM) ACTIVITY: Write an essay that discusses the newspaper articles in the light of the current and the "new" environmental ethic.
7. Review and Evaluation (2.0 h)	

UNIT 10.1 TERRESTRIAL ECOSYSTEMS

The ecosystem concept was introduced in Unit 9.1. This unit reviews, reinforces, and extends the students' familiarity with that concept by applying it to the study of terrestrial ecosystems that range in size from a handful of soil to a biome. Students should discover that the ecological principles which operate in a small local ecosystem also operate in a large biome such as the Canadian tundra.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Survey of Local Ecosystems (1.0 h) *identification of major terrestrial ecosystems in the area (schoolyard, park, woodlot, lawn garden, cornfield, pasture, vacant lot, abandoned field, etc.); basic components of all ecosystems; species diversity of managed and unmanaged ecosystems.*	FILM: The Community (EB)
2. Temperature (1.0 h) *role of temperature as an abiotic factor in terrestrial ecosystems; range of tolerance; optimal temperature; effect of temperature on metabolic processes of plants, poikilotherms, and homeotherms; adaptations of organisms to temperature extremes (a general treatment only).*	ACTIVITY: Library reseach project on adaptations of organisms to temperature extremes.
3. Wind (1.5 h) *roles of wind speed and direction as abiotic factors in terrestrial ecosystems; desirable roles - influence in weather, pollination and seed dispersal; undesirable roles - structural damage to crops and trees, and wind erosion of soil.*	ACTIVITY: A neighbourhood walk to note the direction of the prevailing winds and the effects on vegetation. ACTIVITY: A study of the role of vegetation in the prevention of wind erosion.
4. Water (1.5 h) *role of water as an abiotic factor in terrestrial ecosystems - precipitation, relative humidity and water content of the soil; adaptations of plants and animals to water availability (hydrophytes, xerophytes and mesophytes), water erosion.*	ACTIVITY: Measuring relative humidity.
5. Light (1.5 h) *roles of intensity, duration and quality of light as abiotic factors in terrestrial ecosystems; primary production, phototropism, phototaxis and other adaptations to light conditions; photoperiod.*	ACTIVITY: Projects on effects of light intensity, light direction, light duration, and light quality on plants and animals.
6. Soil (1.5 h) *roles of main soil properties as abiotic factors in terrestrial ecosystems (water content, water holding capacity, porosity, particle size, capillarity, organic content, pH, macronutrients, micronutrients) - a review from Unit 9.2.*	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
7. Study of a Local Ecosystem (2.0 h) *relationships between the abiotic and biotic factors in a local ecosystem such as the schoolyard, a park or a small woodlot; use of the quadrat or line intercept method for calculating frequency, density, cover and importance values (optional).*	ACTIVITY: Field trip to a local ecosystem
8. Major Biomes (3.5 h) *application of ecological principles learned through the study of local ecosystems to the study of some major North American biomes; role of climate in biome formation; climatograms; the tundra (Teach it first since it is the easiest to teach due to short food chains, limited diversity and pronounced adaptations.);other biomes (coniferous forest, temperate deciduous forest, grasslands, desert, mountain, tropical evergreen) - teach one or two of these.*	FILM: The Grasslands (EB) FILM: The Desert (EB) FILM: The Temperate Deciduous Forest (EB) FILM: The High Arctic Biome (EB) FILMSTRIP: The Deciduous Forest (PH) FILM: Living Arctic (NFB) FILM: The Spruce Bog (NFB) FILM: Above the Timberline (NFB) FILM: Edge of the Barrens (NFB)
9. Review and Evaluation (2.0 h)	ACTIVITY: Preparation of a paper dealing in detail with a biome not discussed in class.

UNIT 10.2 ANIMAL SCIENCE

This unit begins with a study of the general characteristics of vertebrate animals and then focuses on the classes Aves and Mammalia, since most important domestic animals belong to these two classes (cattle, pigs, horses, sheep, goats, rabbits, dogs, cats and poultry).

This unit provides a basic understanding of the form and function of mammals and birds. It is not intended to be an exhaustive biological study of these organisms. However, it should provide urban students with a better understanding of farm animals and it should broaden the perspective of rural students who are involved in specialized agriculture.

Check with the science department before beginning this unit in order to avoid needless overlap. The time schedule assumes that students have some familiarity with the systems. If this is not so, you will have to omit two or three systems and one or two activities. As a minimum, do sections 1, 2, 4, 6 and 9.

You should consult Appendix B: Animal Care before beginning this unit.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Two Important Classes of Vertebrates (1.0 h) *characteristics of vertebrates (vertebral column, dorsal nerve cord, gill pouches in the embryo); characteristics of mammals (smooth dry skin with hair, mammary glands, homeothermic); characteristics of birds (smooth dry skin with feathers, eggs with hard shells, wings, homeothermic).*	ACTIVITY: Examination of a vertebral column.
2. Digestive Systems (1.5 h) *basic design of vertebrate digestive systems; unique adaptations in birds, rabbits and ruminants.*	ACTIVITY: Examination of a ruminant stomach (e.g. sheep).
3. Breathing Systems (1.0 h) *the morphology and physiology of bird and mammalian breathing systems.*	ACTIVITY: Examination of pluck (heart, lungs and liver) from a pig.
4. Circulatory Systems (1.0 h) *a brief study of the four-chambered heart of birds and mammals; the roles of arteries, veins and capillaries.*	ACTIVITY: Dissection of a mammalian heart.
5. Excretory Systems (1.0 h) *the morphology and physiology of the kidney; the mammalian excretory system; the bird excretory system.*	ACTIVITY: Dissection of a mammalian kidney.
6. Reproductive Systems (2.5 h) *sexual reproduction; internal fertilization; reproductive systems of birds and mammals; the bird egg; the development of the embryo; birth of mammals; hatching of eggs; artificial insemination; artificial hatching of poultry.*	ACTIVITY: Incubation of eggs.
7. Support and Locomotion Systems (1.0 h) *comparison of morphology and physiology of bird and mammalian skeletons; roles of muscles, tendons and ligaments.*	ACTIVITY: Comparison of a bird and mammalian skeleton.
8. Coordination Systems (1.0 h) *brief reference to endocrine glands, hormones and the functioning of nerve cells.*	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
9. Farm Animals (2.0 h) *common breeds of dairy and beef cattle and their characteristics; similar treatment of one or two other farm animals; selective breeding of egg and meat producing hens and of dairy and beef cattle (descriptive treatment only; no genetics).*	ACTIVITY: Field trip to a spring or fall fair, or to a breeding association.
10. Pet Animals (1.5 h) *common breeds of dogs and one or two other pets; selective breeding; caring for pets (emphasize the importance of understanding the morphology and physiology of the animal systems).*	
11. Careers in Animal Science (1.0 h) *genetics research; veterinarian; veterinarian assistant; rations research and development; design and maintenance of feeding and housing systems; pet store operator; farming; university and college programs.*	GUEST SPEAKER: veterinarian, career counsellor from a college, pet store operator, agricultural engineer.
12. Review and Evaluation (2.0 h)	

UNIT 10.3 PLANT SCIENCE I

This unit surveys the diversity of organisms in the plant kingdom and then focuses on flowering plants. Its main function is to provide a basic introduction to the morphology and physiology of flowering plants to set the stage for subsequent Plant Science units and to make optional units on such topics as Crop Science, Landscaping, Horticulture, Forestry and Gardening more meaningful.

Check with the science department before beginning this unit in order to avoid needless overlap. The time schedule has been kept tight, since students have some familiarity with much of this material.

1. Plant Diversity (1.5 h) *a survey of the major plant phyla, emphasizing two or three characteristics of each phylum; the common characteristics of all members of the plant kingdom.*	ACTIVITY: Examination of representative plants from the main phyla. FILMSTRIP: The Plant Kingdom: A World of Green (S&M)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
2. Characteristics of Flowering Plants (1.0 h) *a survey of some common families of flowering plants (include non-coniferous trees, shrubs and grasses); common characteristics (stress the importance of the flower with an ovary); monocots and dicots.*	ACTIVITY: Examination of several flowering plants to note the main parts (root, stem, leaf and flower).
3. The Flower (2.0 h) *the parts of a flower and their structures and functions (calyx, corolla, stamens and pistil and receptacle); types of flowers (regular vs. irregular, perfect vs. imperfect and monoecious vs. dioecious).*	ACTIVITY: Structure of a simple flower. ACTIVITY: Structure of a composite flower. ACTIVITY: Comparison of self- and cross-pollinated garden and field crops to reflect crop management techniques.
4. Reproduction in Flowering Plants (1.5 h) *production of pollen grains; development of the ovule; pollination; fertilization; development of the embryo.*	FILM: Angiosperms - The Flowering Plants (EBE)
5. Fruits and Seeds (2.0 h) *meaning of fruit; classification of fruits; development of seeds; structure of monocot and dicot seeds; germination of seeds; uses by humans.*	ACTIVITY: Classification of fruits. ACTIVITY: Structure of corn and bean seeds. ACTIVITY: Germination of bean and corn seeds.
6. Roots (1.0 h) *kinds of roots; functions of roots; the root tip; root structure (a generalized discussion only; avoid detailed tissue diagrams).*	ACTIVITY: Examination of the roots of a variety of plants. ACTIVITY: Study of root hairs of radish.
7. Stems (1.0 h) *kinds of stems; functions of stems; stem structure (distinguish between monocot and dicot stems but avoid detailed tissue diagrams); how stems grow.*	ACTIVITY: Classification of an array of plants to identify uses by humans (food, aesthetics, shelter, etc.).
8. Leaves (1.5 h) *general form of a leaf; simple and compound leaves; deciduous and evergreen leaves; cross-section of a leaf; functions of leaves (a brief introduction to transpiration, photosynthesis and respiration - detailed treatment occurs in Plant Science II).*	ACTIVITY: Examination of a variety of leaves.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
9. Ecological Role of Plants (1.0 h) *fixing of energy as carbohydrates; production of oxygen; removal of carbon dioxide from the atmosphere; habitat; soil stabilization; nutrient production (legumes).*	
10. Plants and Agriculture (1.0 h) *survey of important agricultural crops, emphasizing such principles as pollination, seed production and husbandry.*	
11. Plants and Forestry (0.5 h) *use of trees for fuel, paper production and lumber; biomass energy.*	
12. Review and Evaluation (2.0 h)	

UNIT 10.4 ENERGY II

Energy I introduced the concept of energy and developed the distinction between renewable and nonrenewable energy sources. It also considered the consumption and resources of energy in order to clarify the seriousness of the petroleum crisis. This unit reviews and extends the students' knowledge of renewable and nonrenewable energy sources by treating them in more detail. Then the distinction between societal needs and wants is debated so students can rationally consider energy conservation and the development of new energy sources as alternative methods of alleviating the petroleum crisis.

1. Review of Energy I (1.0 h) *meaning of energy; forms and characteristics of energy; renewable and nonrenewable sources.*	FILM: Energy: The Fuels and Man (NG) FILMSTRIP: The Fuel Crisis (PH)
2. Fossil Fuels (3.5 h) *formation of coal, petroleum and natural gas; mining of coal (methods and environmental problems); extraction and transportation of petroleum and natural gas (methods and environmental problems); fractionation of petroleum; Canadian and world resources of coal, petroleum and natural gas; environmental problems associated with combustion of fossil fuels; non-conventional sources of fossil fuels (tar sands and shale rock); consideration of types and grades of automobile fuels.*	ACTIVITY: Destructive distillation of coal. ACTIVITY: Fractional distillation. FILMSTRIP: Fossil Fuels (NG) ACTIVITY: The Composition of Tar Sand (Quantitative).

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
3. Nuclear Energy (1.5 h) *meaning of nuclear fission; the CANDU reactor; comparison to the USA breeder reactor; generating electricity with nuclear reactors; pros and cons of nuclear energy; nuclear fusion.*	FILMSTRIP: Nuclear Energy (PH) FILMSTRIP: Nuclear Energy: Peril or Promise (S&M) FILMSTRIP: Nuclear Power (NG)
4. Trapping Solar Energy (2.0 h) *structure and use of reflectors, flat-plate collectors and photo-voltaic cells; active and passive methods for heating buildings; pros and cons of solar energy.*	FILMSTRIP: Harnessing the Sun (NG) ACTIVITY: Operation of a photo-voltaic cell. ACTIVITY: Building a flat-plate collector (if not done in Energy I).
5. Energy from Biomass (1.0 h) *review photosynthesis; the principle behind biomass energy; methanol from trees; ethanol from grain; energy from the burning of wood; methane from anaerobic decay of organic matter; pros and cons of biomass energy.*	ACTIVITY: Destructive distillation of wood. FILM: Energy from the Sun (EB)
6. Energy from Water (0.5 h) *hydroelectric power plants on rivers; harnessing the tides; pros and cons of energy from water.*	SOUND-SLIDE: Renewable Energy Sources: Wind, Water and Solar Rays (S&M)
7. Wind Energy (0.5 h) *historical use; the Darrieus rotor windmill; other designs; pros and cons of wind energy.*	Activity: Refer to Energy in Society Resource Guide, 1978, Ministry of Education.
8. Geothermal Energy (0.5 h) *origin; main sites on earth; harnessing geothermal energy; pros and cons of geothermal energy.*	
9. Hydrogen as a Fuel (1.0 h) *sources; pros and cons.*	ACTIVITY: The combustion of hydrogen.
10. Energy Needs or Wants? (1.5 h) *distinction between societal needs and wants that require energy; conservation and development of new energy sources as alternative methods for alleviating the petroleum crisis.*	SOUND-SLIDE: Critical Issues in Science and Society: The Great Energy Debate (S&M)
11. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES

UNIT 10.5 HUMANS IN THE ENVIRONMENT II

This unit deals primarily with resource management, which is the manipulation of ecosystems to maximize the flow of energy and materials to humans. Many of the topics in this unit are covered in detail in other units of this document. Therefore, do not attempt an exhaustive treatment here. Instead, use this discussion of resource management to further develop the environmental ethic introduced in Humans in the Environment I. You can do this by emphasizing two things:

a) Why is the resource being managed; to satisfy a need or a want?

b) What procedures are being used? Do they reflect an ethic of dominance and progress or an ethic that is based on a respect for all forms of life and an understanding of the ecosystem concept?

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Classification of Natural Resources (0.5 h) *renewable resources such as forests, wildlife, fish, water, air and land ; non-renewable resources (mineral reserves) such as coal, petroleum, aggregate, uranium and iron ore.*	FILM: Problems of Conservation: Our Natural Resources (EB)
2. Forest Management (2.0 h) *forest regions in Ontario - main species and uses; harvesting methods; disease control; regeneration methods; management of farm woodlots; consideration of environmental ethics.*	FILM: Forest Regions of Canada (NFB) FILM: Foresters (NFB) FILM: Woodlot Management (NFB)
3. Wildlife Management (2.5 h) *management of game animals such as deer and waterfowl; management of furbearers; management of endangered species; consideration of environmental ethics; study of hunting, fishing and trapping regulations.*	FILM: Problems of Conservation: Wildlife (EB) FILM: The Beaver Makes a Comback (NFB) FILM: Waterfowl - A Resource in Danger (NFB) ACTIVITY: Debate on the ethics of sport hunting.
4. Fish Management (1.5 h) *identification of managed species; stream improvement techniques; management of lake species; fish from the oceans; consideration of environmental ethics; the fishing industry in Ontario.*	FILM: Trout Stream (NFB)
5. Soil Management (2.0 h) *soil: renewable or nonrenewable? preventing wind and water erosion; maintaining nutrient levels; restoring lost organic matter; tillage procedures; consideration of environmental ethics.*	FILMSTRIP: Soil: Its Meaning for Man (PH) FILM: Problems of Conservation: Soil (EB)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Aggregate Extraction (2.0 h) *types of aggregate; main sources in Ontario; uses of aggregate; extraction procedures; reclamation of gravel pits and quarries; the Niagara Escarpment issue; consideration of environmental ethics.*	ACTIVITY: Debate on the Niagara Escarpment issue using background information from the Niagara Escarpment Commission.
7. Mining of Mineral Reserves (1.5 h) *a consideration of one or two examples, emphasizing location of the reserve, uses, extraction methods and environmental ethics.*	FILM: Miner (NFB) FILM: Problems of Conservation: Minerals (EB) ACTIVITY: Research a mineral resource - sources, uses, and conservation measures.
8. Review and Evaluation (2.0 h)	ACTIVITY: Study of "Pit and Quarry Rehabilitation" (Ontario Ministry of Natural Resources).

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 11.1 AQUATIC ECOSYSTEMS	
The ecosystem concept was introduced in Unit 9.1 and extended to terrestrial ecosystems in Unit 10.1. In this unit students have the opportunity to extend their knowledge of the ecosystem concept into the realm of aquatic ecosystems.	
Particular attention should be given to human impact on aquatic ecosystems, in particular, water pollution. Students should know the sources, effects and control measures for common water pollutants under the broad headings of domestic sewage, agricultural runoff and industrial effluents.	
1. Freshwater Ecosystems: Standing Waters (1.5 h) *distinction between ponds and lakes; pond or lake succession; marshes and swamps; autotrophic and detritus food chains; spring and fall overturn; algal blooms.*	FILM: Around a Big Lake (IFB) FILM: World in a Marsh (NFB)
2. Freshwater Ecosystems: Flowing Waters (1.0 h) *types of running waters; importance of detritus food chains; adaptations of organisms to their physical environments.*	FILMSTRIP: Exploring Ecology - The River (NG)
3. Abiotic Factors in Aquatic Ecosystems (3.0 h) *physical factors such as temperature, speed and turbidity; chemical factors such as oxygen, carbon dioxide, pH, alkalinity, hardness, nitrogen and phosphorus; total suspended solids; total dissolved solids.*	ACTIVITY: Relationship between temperature, oxygen and metabolic rate. ACTIVITY: Analyzing the water in a classroom ecosystem. ACTIVITY: A long-term study of a mini-ecosystem.
4. Index Species and Species Diversity (0.5 h) *meaning of index (indicator) species; relationship between water quality and species diversity.*	
5. Eutrophication (1.0 h) *natural eutrophication; how humans accelerate eutrophication; procedures for lessening our contribution to eutrophication. (reductions in domestic sewage, agricultural runoff, and industrial effluents).*	ACTIVITY: Effects of organic matter on water quality.
6. Fish and Water Quality (1.0 h) *effects of domestic and industrial effluents on species diversity and population numbers in the Great Lakes; indicator species in rivers and lakes.*	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
7. Bottom Fauna and Water Quality (1.5 h) *effects of physical factors such as bottom type, speed and temperature on the bottom fauna community; effects of chemical factors; indicator species in rivers and lakes.*	ACTIVITY: Use of a dichotomous key to identify aquatic invertebrates to order.
8. Algae and Water Quality (1.0 h) *changes in algal diversity as water quality changes; blue-green algae, desmids and diatoms as indicator species.*	SLIDES: A Survey of the Algae (Ward's) ACTIVITY: Examination of prepared slides and living cultures of representative algae.
9. Bacteria and Water Quality (1.0 h) *coliform bacteria and fecal coliforms as indicators of water quality; provincial standards for drinking water and swimming areas; testing methods.*	ACTIVITY: Determination of coliform count using membrane filtration or Millipore's "Coli-count Samples". ACTIVITY: Field trip to a freshwater ecosystem
10. Marine Ecosystems (1.5 h) *identification of marine (saltwater) ecosystems in Ontario; salinity as an abiotic factor; ecology of the open ocean; zonation of organisms on a rocky shore; tidal marshes; human impact through oil spills, harbour dredging, and water pollution.*	FILMSTRIP: Shores: The Edges of Things (PH) - a series of 6 FILMSTRIP: The Wetlands (PH) - a series of 2, one on salt-water and one on freshwater ecosystems
11. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 11.2 AIR QUALITY	
Air pollution was once thought to be an urban problem. However, recent studies have shown that air pollution affects forests, agricultural crops, lakes and soils, as well as the health of humans and other animals. In this unit students study the sources and effects of common air pollutants and then examine abatement procedures.	
1. The Atmosphere (1.0 h) *layers of the atmosphere (troposphere, stratosphere, mesosphere, thermosphere and ionosphere ozone layer; composition of clean dry air.*	ACTIVITY: Percent oxygen in air. FILMSTRIP: Air Pollution Part 1 (PH) FILM: Air is Life (IFB)
2. Particulates (2.0 h) *types of particulates; sources; effects on human health; possible effect on global climate; controls through market incentives (voluntary) and legislation; contribution of tobacco smoke.*	ACTIVITY: Dustfall per unit area. ACTIVITY: Microscopic examination of particulate matter.
3. Sulfur Dioxide (2.0 h) *properties; sources; effects on human health, vegetation, metals and fabrics; lichens as indicators; acid precipitation; controls (conservation, scrubbers, using nuclear power); the Air Pollution Index; Ontario's main producers of sulfur dioxide; importance of sources in the United States; contribution of tobacco smoke.*	TEACHER DEMONSTRATION: Effects of sulfur dioxide on plants, metals and fabrics. CAUTION: This activity must be done in a fumehood. FILM: Air Pollution (SEF)
4. Carbon Monoxide (1.0 h) *properties; sources; effects (relate to its haemoglobin affinity) controls; contribution of tobacco smoke.*	ACTIVITY: Use of gas sampling tubes to measure concentrations in parking garages, car exhaust, cigarette smoke and smoky rooms.
5. Carbon Dioxide (1.0 h) *properties; sources; effects (emphasize the "greenhouse effect"); controls.*	ACTIVITY: Complete and incomplete combustion of a hydrocarbon (acetylene).
6. Nitrogen Oxides (1.0 h) *properties of nitric oxide and nitrogen dioxide; sources; nitrogen dioxide as a contributor to acid precipitation; effects on human health, vegetation and fabrics; controls; contribution of tobacco smoke.*	TEACHER DEMONSTRATION: Effects on plants, metals and fabrics. CAUTION: This activity must be done in a fumehood. FILM: Pollution of the Upper and Lower Atmosphere (LCA)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
7. Ozone (0.5 h) *properties; the ozone layer; sources; effects on human health, vegetation, rubber and fabrics, controls.*	FILM: Problems of Conservation: Air (EBE)
8. Hydrocarbons (0.5 h) *common hydrocarbons; sources; effects, controls.*	ACTIVITY: Use of gas sampling tubes to measure concentrations in heavy traffic, in car exhaust and near filling stations.
9. Other Pollutants (0.5 h) *one or two locally important airborne pollutants could be discussed: lead, asbestos, PVC's, radioactive particles.*	ACTIVITY: Literature research project on a locally important pollutant.
10. Temperature Inversions (1.0 h) *how inversions are formed; effects.*	ACTIVITY: Formation of an air inversion.
11. Photochemical Smog (0.5 h) *raw materials; conditions promoting photochemical smog; the catalyst; products; effects.*	FILMSTRIP: Air Pollution, Part 2 (PH)
12. Tobacco Smoke (2.0 h) *summarize data introduced in this unit; health effects; non-smokers' rights.*	ACTIVITY: Debate on the rights of smokers and non-smokers. ACTIVITY: The destructive distillation of tobacco. ACTIVITY: Use of a smoking machine to study tobacco smoke.
13. Review and Evaluation (2.0 h)	

UNIT 11.3 PLANT SCIENCE II

This unit provides students with a basic knowledge of plant physiology which they then use during a practical study of the care and propagation of plants. If your students have done the laboratory work on photosynthesis and respiration in a science course, do not repeat it here. Do, however, review and summarize the key concepts.

1. Factors Affecting Plant Growth (0.5 h) *a general discussion to ascertain student backgrounds and set the stage for the rest of this unit: temperature, light, oxygen, carbon dioxide, water, minerals and humidity.*	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
2. Absorption of Water and Nutrients by Roots (1.5 h) *diffusion and osmosis; root structure (emphasize xylem, phloem, epidermis and root hairs); absorption of water; absorption of nutrients; effects of excess water or nutrients.*	FILM: Osmosis (EBE) ACTIVITY: Absorption and transport of water by roots. ACTIVITY: Examination of longitudinal and cross sections of a root.
3. Transport by Stems (1.5 h) *structure of monocot and dicot stems (emphasize xylem, phloem, epidermis); transport of water, nutrients and glucose; how stems grow; twigs and buds.*	ACTIVITY: Examination of cross sections of monocot, young dicot and woody dicot stems. ACTIVITY: Movement of water up stems. ACTIVITY: Study of twigs and buds.
4. Photosynthesis (2.0 h) *reactants; conditions; products; summation equation; (mechanism not required).*	FILMSTRIP: Photosynthesis: Energy from Light (S&M) ACTIVITY: Experiments to establish reactants, conditions and products. FILM: Photosynthesis (EBE)
5. Respiration (1.0 h) *reactants; conditions; products; summation equation.*	FILMSTRIP: Respiration: Energy for Life (S&M) ACTIVITY: Respiration by germinating seeds.
6. Transpiration (1.0 h) *meaning; functions; factors affecting the rate.*	ACTIVITY: Transpiration by a plant.
7. Leaf Structure and Function (1.5 h) *cross section of a leaf; guard cells and their role in the regulation of gas exchange and transpiration.*	ACTIVITY: Examination of a leaf epidermis. ACTIVITY: Examination of a leaf cross section.
8. Plant Hormones (1.5 h) *role of plant hormones (auxins, gibberellins and cytokinins);*	ACTIVITY: Effects of an auxin. ACTIVITY: Effects of gibberellic acid.
9. Plant Movements (1.5 h) *tropisms; turgor movements; circadian rhythms.*	FILM: Plant Motions (EBE) ACTIVITY: Study of one or two tropisms.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
10. Care and Propagation of Plants (2.0 h) *conditions for maintaining cuttings; conditions for successful transplanting; feeding and water regimens.*	ACTIVITY: Making and maintaining cuttings which are transplanted to the school or home garden.
11. Review and Evaluation (2.0 h)	

UNIT 11.4 ENERGY III

This unit emphasizes energy conservation in the home and workplace and in transportation. The emphasis should be placed upon the idea that it is the individual's responsibility to be an energy conserver, not just to save money, but to be a good citizen. (See Energy in Society, Resource Guide, 1978, available from the Ministry of Education.

1. Decreasing Heat Transfer in Homes (2.0 h) *use of insulation to lessen heat loss; caulking and weather stripping; glazed windows; storm windows and doors; use of drapes.*	SOUND-SLIDE: Living with a Limit: Practical Ideas for Energy Conservation (S&M) FILMSTRIP: The Wise Use of Energy (PH)
2. Insulation and R Values (2.5 h) *meaning of R value; common insulation materials and R values; R values of building materials; recommended minimum R values for ceilings, walls and floors; retrofitting an older house.*	ACTIVITY: Prepare a plan for retrofitting a house. FILMSTRIP: Energy and the Home (NFB) FILM: The Hottest Show on Earth (NFB) FILM: The Insulation Story (NFB)
3. Measuring Electrical Energy (2.0 h) *power ratings of lights and appliances; current and potential; calculating power; reading an electric meter.*	ACTIVITY: Comparing the use of electricity in the home during a "regular" week and a "conservation" week.
4. Conserving Electrical Energy (1.5 h) *ways to conserve electricity in the home; lifestyle and energy consumption.*	
5. Cars and Energy (4.0 h) *review of the petroleum crisis; characteristics of a car that affect its fuel consumption; driving habits that increase fuel consumption; common characteristics of fuel efficient cars; deciding what car to buy and how to drive it; evaluation of decisions using environmental ethics; conserving energy by using other forms of transportation.*	ACTIVITY: Use the "Fuel Consumption Guide" to discover the common features of fuel efficient cars. ACTIVITY: Debate the relative merits of market incentives and legislative methods of encouraging the use of small cars and the decreased use of fuel by motorists.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Review and Evaluation (2.0 h)	FILMSTRIP: Energy and Transportation (NFB) FILMSTRIP: Energy and Leisure (NFB) FILMSTRIP: A Practical Guide to the Energy Crisis (PH) FILMSTRIP: The Automobile: Social and Economic Impact (PH)

UNIT 11.5 HUMANS IN THE ENVIRONMENT III

After considering the positive and negative effects of human activities, this unit establishes the need for "wild" areas and then investigates the policies and procedures at various levels of government which provide for such areas. Here, too, students should be encouraged to use their personal environmental ethics when they are evaluating such things as provincial parks policy.

1. Positive Effects of Human Activities (1.5 h) *increased lifespan; decreased disease; increased food production; creativity.*	
2. Negative Effects of Human Activities (2.0 h) *petroleum crisis; flooding; air pollution; water pollution; eutrophication; solid waste; hazardous liquid wastes; climatic change; species extinction; pest outbreaks; soil erosion; famine.*	FILMSTRIP: Vanishing Animals of North America (NG) - series of 5 FILMSTRIP: Endangered Species (PH)
3. The Need for Wild Areas (1.5 h) *gene pool for organisms; recreation; psychological need to know such areas exist.*	FILMSTRIP: Extinction and Endangered Species: Natural Process or Human Intervention? (S&M) FILM: The Enduring Wilderness (NFB)
4. National Parks (2.0 h) *national parks policy; federal departments and agencies involved with national parks; number, distribution, functions and features of national parks; importance to humans; importance to organisms; citizen groups interested in national parks.*	ACTIVITY: A study of federal documents on national parks policy. ACTIVITY: Write a paper on a national park (history, location, functions, features, size). Nature Canada, Special Issue, March, 1981 surveys our national parks.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Provincial Parks (2.5 h) *provincial parks policy; the Ontario Ministry of Natural Resources· Parks Branch; parks classification system; number, distribution, functions and features of provincial parks; importance to humans; importance to organisms; citizen groups interested in provincial parks .*	ACTIVITY: Evaluation of a masterplan for a provincial park.
6. Conservation Authorities in Ontario (1.5 h) *origin; nature; mandate; the purpose, makeup and past and present projects of the local conservation authority; meaning of conservation; how the local authority "conserves".*	ACTIVITY: Field trip to a local conservation area.
7. Parks Policy and Environmental Ethics (1.5 h) *evaluation of federal, provincial and local parks policy in the light of the students' personal environmental ethics; how to contact the appropriate officials to voice an opinion.*	ACTIVITY: Write a letter on an important federal, provincial or local environmental issue. GUEST SPEAKER: A visit by a leader of a public interest group involved in parks policy.
8. Review and Evaluation (2.0 h)	

UNIT 12.1 PESTICIDES IN THE ENVIRONMENT

The use of pesticides has contributed positively to the food supply, life expectancy, health and comfort of people in many countries but, in contrast, the overuse and misuse of pesticides has created serious environmental problems that may ultimately outweigh the positive effects. This unit explores the types, nature and functions of pesticides, clarifies their positive and negative features, and outlines proper procedures for using them.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Overview of Pest Control (1.5 h) *meaning of pest; categories of pests (insects, fungi, weeds, rodents, etc.); benefits of pest control; effects on an ecosystem of eradication of a pest; comparison of two approaches to pest control - total eradication versus an ecosystem management approach; types of chemical pesticides - insecticides, herbicides, fungicides, rodenticides, miticides.*	FILM: Food or Famine (Shell Oil)
2. The History of Chemical Pesticides (1.5 h) *first-generation (inorganic) pesticides such as compounds of lead, arsenic and mercury; DDT, the first of the second-generation (synthetic organic) pesticides - its apparent virtues and problems; banning of DDT in Canada; use in other countries; 2,4-D (the first selective herbicide); atrazine (a super-selective herbicide).*	ACTIVITY: Debate the pros and cons of using DDT.
3. Forms, Properties and Effects of Pesticides (1.0 h) *forms - gas, dust, wettable powder, liquid emulsions; surface versus systemic; selective versus broad spectrum; water soluble versus fat soluble; persistent versus biodegradable.*	ACTIVITY: Study of appropriate sections of "Pesticides Safety Handbook" (MOE).
4. Common Chemical Insectides (1.0 h) *main classes of synthetic organic insectides and their general properties:* *a) organochlorides (chlorinated hydrocarbons)* *- aldrin, chordane, DDT, dieldrin, endosulfan, endrin, heptachlor, lindane, mirex, toxaphene* *b) organophosphates* *- diazinon, malathion, parathion* *c) carbamates* *- carbaryl*	ACTIVITY: Classification of insecticides using labels and "Pesticides Safety Handbook" (MOE). Example: Sevin is the trade name of an insecticide in the sub-class carbaryl and class carbamate.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Action of Insecticides (1.0 h) *contact insecticides; residual insecticides; stomach (oral) poisons; systemic insecticides; fumigants; development of resistance; bioaccumulation.*	FILMSTRIP: Pesticides: Safe Handling and Use (BPI) - 6 parts
6. Common Chemical Herbicides (1.0 h) *main classes of synthetic organic herbicides and their general properties:* *a) chlorophenoxy compounds* *2,4-D, 2,4,5-T, MCPB* *b) triazines* *- atrazine, simazine, propazine, amitrole* *c) substituted ureas* *- fenuron, monuron, diuron, linuron* *d) carbamates* *- barban, propham, triallate*	ACTIVITY: Study of appropriate sections of "Pesticides Safety Handbook" (MOE). ACTIVITY: Classification and uses of common herbicides - using labels, advertisements and the "Pesticides Safety Handbook" (MOE) Include those in common use: Roundup, Silvex, Blazine, Bladex, Lasso, Treflan, AAtrex, Sutan +.
7. Action of Herbicides (1.0 h) *contact herbicides; systemic (translocated) herbicides; growth regulators; selective and non-selective herbicides; pre-plant, pre-emergent and post-emergent herbicides.*	ACTIVITY: Demonstration of effectiveness of herbicides on test plots.
8. Fungicides (0.5 h) *protective fungicides; eradicant fungicides; action of two or three common fungicides (e.g., captan, zineb).*	
9. Botanical Pesticides (0.5 h) *derivation; misleading designation as "organic"; common examples and their uses (pyrethrins, rotenone, nicotine).*	
10. Toxicity to Humans (1.0 h) *meaning of LD_{50}; means of absorption; effects of some common pesticides; safety precautions.*	ACTIVITY: Study of appropriate sections of "Pesticides Safety Handbook" (MOE).
11. Toxicity to Fish and Wildlife (0.5 h) *effects of some common pesticides; means of transmission; pesticides in food chains; safety precautions.*	FILMSTRIP: Pest Management: An Integrated Approach (VEP) - 5 parts
12. Alternatives to Chemical Pest Control (1.0 h) *use of natural enemies; sterilization techniques; hormonal control; sex attractants; use of resistant strains of crops; IPM (Integrated Pest Management).*	FILM: The World of Insects (NG) FILM: The Insect Alternative (TL)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
13. The Politics and Economics of Pesticide Use (1.5 h) *common pesticides in the students' homes; common pesticides on farms and in greenhouses (where applicable); groups to whom pesticides are important; use in forest management; licensing for pesticide use; misuse of pesticides in urban and rural areas; political and economic realities.*	ACTIVITY: Debate whether or not a specific pesticide should be used (e.g., atrazine on cornfields).
14. Review and Evaluation (2.0 h)	

UNIT 12.2 LAND USE

This unit examines the factors and forces behind current trends in land use and then proceeds with a study of land use conflicts. The importance of preserving agricultural land and public open space should be emphasized.

1. Variety of Land Uses (1.0 h) *types of land uses; dependency of all other resources on land; interaction of land uses; land use capability classification for agriculture.*	FILMSTRIP: Land: Uses and Values (PH) ACTIVITY: Use of aerial photographs and topographical maps to investigate the nature or urban growth.
2. Land Use Conflicts (3.0 h) *metropolitan growth as the core of land use conflicts; nature of the urban-rural fringe; urban sprawl; land use and resource conflicts derived from urban sprawl (loss of agricultural land, degradation of water resources conflicts of highways, energy extravagance, pollution, waste disposal).*	FILMSTRIP: The Housing Crisis (PH) ACTIVITY: Study of appropriate sections of "Canada's Special Resource Lands" (Environment Canada). FILMSTRIP: Living in the City (NG) FILM: The City and its Region (NFB) ACTIVITY: Study of "Land Use Dynamics on the Toronto Urban Fringe" (Environment Canada).
3. Suburban Growth (2.5 h) *factors responsible for suburban growth; migration trends; decline of the central city; role of the automobile; racial and economic segregation.*	FILMSTRIP: The Growth of the City (NG) ACTIVITY: Field trip to a housing development.
4. Reversing the Trend to Urban Sprawl and Central City Decay (3.5 h) *changing attitudes towards city living; controlling urban sprawl; land use planning; zoning regulations; protecting agricultural land; roles of satellite cities;*	FILM: To Build a Better City (NFB) ACTIVITY: Debate this statement: "Can cities be attractive, pleasant, rewarding places to live?"

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
rehabilitating the central city; greenspace, parks and urban natural areas.	FILMSTRIP: Toward a Better City (NG)
5. Open Space Land (2.0 h) *importance; the trend towards private ownership of accessible open space; the effects on agricultural communities; the need for public ownership; resolving the private-public conflict; Ontario's Trespass Laws; non-use of land (wilderness areas).*	ACTIVITY: Debate the issue of public or private ownership of recreational open space. ACTIVITY: Study session using the "Trespass to Property", "Occupiers' Liability", and "Rights to Access" acts.
6. Review and Evaluation (2.0 h)	

UNIT 12.3 PLANT SCIENCE III

This unit begins with a study of plant propagation, both sexual and asexual. Mendelian genetics is then introduced in order to provide students with the basic knowledge required for an understanding of the science of plant breeding.

1. Review of Plant Science I and II (1.0 h) *plant needs; plant processes; growth regulants (hormones).*	FILMSTRIPS: Sexual Reproduction of a Flowering Plant (PH) 1. Chromosome and Genes 2. Male and Female Structures 3. Meiosis-Reduction Division 4. Pollen and Ovule Development 5. Pollination and Fertilization 6. Mitosis and Cell Differentiation 7. Inherited Traits and Variations
2. Plant Propagation: Sexual (2.0 h) *review of pollination, fertilization, seed and fruit production; annuals, biennials and perennials; monocot and dicot seeds; life span of seeds; dormancy; conditions for germination; scarification; planting and maintaining seed beds.*	ACTIVITY: Germination of a variety of seeds in a number of environments (outdoors, classroom, greenhouse, cold frame).
3. Plant Propagation: Asexual (2.0 h) *meaning of vegetative (asexual) methods; use of cuttings; division of roots or underground stems; grafting; budding; layering.*	ACTIVITY: Vegetative reproduction of plants.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
4. Plant Mitosis and Development (1.5 h) *importance to genetic continuity; phases in mitosis; cell development; growth; differentiation.*	ACTIVITY: Microscopic study of plant mitosis.
5. Plant Meiosis (1.5 h) *chromosome number and structure; genes; homologues; diploid and haploid numbers; genetic variation; adaptation.*	SOUND-SLIDE: Genetics: Observing Patterns of Inheritance (S&M)
6. Mendelian Genetics (2.0 h) *Mendel's experiments; hybridization; dominant and recessive genes; monohybrid and dihybrid crosses; Law of Dominance; Law of Segregation; phenotype and genotype.*	ACTIVITY: Transmission of traits in corn and soybeans.
7. Variations (1.5 h) *heredity and environment; Theory of Natural Selection; gene pool; random mating; mutations; meaning of species, subspecies, variety and form.*	FILMSTRIP: How Life Survives: Adaptation and Evolution (S&M) ACTIVITY: Mutation studies in plants using irradiated seeds
3. Plant Breeding (2.0 h) *purpose; history; mass selection; hybridization; hybrid vigour; inbreeding; breeding modern hybrid corn; new plant strains by mutations; chromosome polyploidy; values of plant breeding; problems.*	ACTIVITY: Comparing hybrid corns using growth plots.
9. Review and Evaluation (2.0 h)	

UNIT 12.4 ENERGY IV

This unit extends the energy conservation theme of Energy III, the emphasis being placed upon things the students can do now to conserve energy. Then the unit prepares the students to be energy conservers in the future by investigating lifestyles, housing alternatives, transportation modes and energy sources that will be found in a true conserver society.

1. Energy and the Home (1.5 h) *direct uses of energy in the home (heating, cooking, lighting, air conditioning, refrigeration); indirect uses of energy in the home (packaging, failure to recycle and repair, foods); alternate methods of providing energy for direct uses (heat pumps, solar heating, solar cooking); reducing direct uses of energy; reducing indirect uses of energy.*	ACTIVITY: Throughout this unit use selected activities from "Energy Management for the Future" (Energy, Mines and Resources, Canada) and from "Energy in Society" (Ministry of Education). FILMSTRIP: Energy and the Home (NFB) FILM: The Hottest Show on Earth (NFB)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
2. Energy and Food (1.5 h) *agricultural uses of energy (tillage, harvesting, transportation, fertilizer, pesticides); energy costs of food packaging; energy costs of "fast foods"; soft-drink containers and energy.*	FILMSTRIP: Energy and Food (NFB)
3. Energy and Leisure Time (2.0 h) *the leisure time problem; high energy consumption leisure time activities; low energy consumption leisure time activities; criteria for selecting leisure time activities.*	FILMSTRIP: Energy and Leisure (NFB) ACTIVITY: Calculation of Lifestyle and Energy Use Index using "Energy Management for the Future" (Energy, Mines and Resouces, Canada).
4. Energy and Transportation (2.0 h) *role of transportation in our society; direct uses of energy in transportation; indirect uses; modes of transportation and their relative energy requirements; energy conservation through increased efficiency and new design concepts; energy conservation through lifestyle changes.*	FILMSTRIP: Energy and Transportation (NFB) FILM: What on Earth! (NFB) FILM: Bate's Car: Sweet as a Nut (NFB)
5. Landscape and Architectural Design for Solar Technology (2.5 h) *passive and active solar heating; maximizing passive solar heating; home design and placement for solar heating; landscaping for energy conservation; future solar dwellings.*	SOUND-SLIDE: Solar Energy: Putting Sunshine in Your Life (S&M) ACTIVITY: Prepare a plan for a solar home, including a landscaping plan. ACTIVITY: Build a working model of a flat-plate collector. ACTIVITY: The operation of a photovoltaic cell.
6. Future Energy Sources (2.0 h) *review and extend the appropriate sections of Energy II; frontier exploration for petroleum; energy self-sufficiency for Canada.*	FILMSTRIP: Energy for the Future (NG) FILM: Energy: the Problems and the Future (NG)
7. Solving the Energy Problem (2.0 h) *summary of technological solutions; summary of lifestyle solutions; the best plan for the future.*	FILM: Energy: The Problems and the Future (NG) ACTIVITY: Debate the pros and cons of technological and lifestyle solutions. FILMSTRIP: Energy (PH)
8. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT 12.5 HUMANS IN THE ENVIRONMENT IV	
This unit begins by helping the students formalize a personal environmental ethic. It then gives the students opportunities to test their ethic in decision-making situations of local, national and international importance.	
1. A Personal Environmental Ethic (1.5 h) *review and re-evaluation of the ethic developed in "Humans in the Environment I, II and III"; the need for a personal environmental ethic in decision-making situations; how personal ethics determine societal ethics.*	FILMSTRIP: The Beer Can by the Highway (PH) ACTIVITY: Write a paper expressing one's personal environmental ethic. Include a discussion of its application in one or two decision-making situations.
2. A Strategy for Decision-Making (1.5 h) *how to decide what constitutes environmentally acceptable actions: the roles of ethics, knowledge, and societal needs; legal aspects; consideration of present and future dimensions.*	ACTIVITY: Prepare a flow chart showing the approach used to make a decision on a specific environmental matter.
3. Measuring Attitudes and Behaviours (2.5 h) *preparation and administration of attitude-behaviour studies; data analysis; using the data to change attitudes and behaviours.*	ACTIVITY: Prepare, administer and analyze an attitude-behaviour study on an environmental matter.
4. Debating Controversial Issues (3.0 h) *preparation and conduct of debates on emotional environmental issues such as sport hunting, trapping, off-road vehicles and smoking in public places;role of a personal environmental ethic and the decision-making strategy in such debates.*	FILM: Say Goodbye (VEC) FILM: Death of a Legend (NFB) SOUND-SLIDE: The Science and Ethics of Population Control: An Overburdened Earth! (S&M)
5. Feeding the World (1.5 h) *global population problems; global food problems; global distribution of agricultural and other food resources; food exporting and importing countries; ethical questions relating to feeding underfed populations.*	FILMSTRIP: Food, Will There Be Enough? (PH) SOUND-SLIDE: Critical Issues in Science and Society: A World to Feed (S&M) FILMSTRIP: World Resources and Responsibilities (PH) FILM: Food or Famine (Shell Oil)
6. The Conserver Society (1.5 h) *concern for the future; economy of design; recognition of total costs of our actions; personal responsibility; respect for the biosphere; minimizing human impact on the biosphere.*	ACTIVITY: Study of appropriate sections of "Canada as a Conserver Society:, Science Council of Canada Report #27.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
7. Consumer Behaviour (1.5 h) *consideration of packaging; lifestyle; advertising; convenience foods; food storage; cooking methods; growth of fast food services.* 8. Review and Evaluation (2.0 h)	

UNIT A.1 DOMESTIC ANIMALS I

This unit provides a basic introduction to human/animal relationships. Its major objective is to develop an informed and responsible attitude toward the care of pet animals and farm animals. A section on wild animals is included to emphasize that our responsibility for animal welfare should not be limited to those animals that we have chosen to domesticate.

Many animals suffer needlessly because some humans are ignorant of their needs and behave irresponsibly when they assume the care of animals. You may wish to alter the suggested time allotments in order that you can emphasize areas of particular relevance to your students. If possible, conduct at least one of the field trips.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Human/Animal Relationships (1.5 h) *similarities and differences between humans and animals; human uses of animals; human attitudes toward animals; careers that involve working with and for animals.*	
2. Animal Welfare (1.0 h) *laws that protect animals; role of the Humane Society; animal welfare organizations; individual responsibility.*	FILM: The Animals are Crying (LCA) ACTIVITY: Speaker from the Humane Society, Fund for Animals, World Wildlife Fund or other animal welfare organization.
3. Pet Animals (1.0 h) *functions of pet animals; factors to consider when choosing a pet; characteristics of good pet animals.*	ACTIVITY: The choice and care of a classroom pet. FILMSTRIP: The Small Animal Care Kit (VEP) - 5 parts
4. Pet Needs (2.5 h) *dependency of pets on owners; need for training and control; rations, accommodations, exercise schedule, grooming and training of selected pets such as dogs, cats, rabbits, hampsters and gerbils; consequences of irresponsible behaviour by pet owners.*	ACTIVITY: Visit to a pet store, pet section of a department store, or kennels. ACTIVITY: Observe behaviour of people towards dogs and write an analytical report.
5. Farm Animals (2.5 h) *types of farm animals; human uses of farm animals; meaning of domestication; human responsibility to provide for farm animals' physical and behavioural needs; feeds and rations; feed additives.*	ACTIVITY: Field trip to a spring fair, fall fair, breeders' association or a variety of farms (mixed).

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Farm Animals and Food Production (2.0 h) *types of foods derived from animals; techniques for maximizing the food conversion ratio; animal suffering during the food production process; alleviating suffering; alternatives to farm animal products.*	ACTIVITY: Field trip to a slaughter house.
7. Wild Animals (2.0 h) *importance of wild animals in ecosystems; human responsibilities toward wildlife; wild animals in zoos; wild animals as pets; human role in creating threatened, endangered and extinct species; habitat destruction; sport hunting; trapping and the fur business.*	FILM: The Animals Nobody Loved (NG) ACTIVITY: Visit to a zoo or other wild animal sanctuary. FILM: Zoos of the World (NG) ACTIVITY: Debate the pros and cons of sport hunting or fur harvesting. ACTIVITY: A speaker on sport hunting or fur harvesting (a trapper, fur dealer, hunter or officer from the Ministry of Natural Resources).
8. Review and Evaluation (2.0 h)	

UNIT A.2 DOMESTIC ANIMALS II

Domestic Animals II, III and IV are designed primarily for students in agricultural areas. If possible, Unit 10.2, Animal Science, should be taught prior to these units, since it provides a basic introduction to animal morphology and physiology.

This unit reviews the major organ systems introduced in Unit 10.2 and then treats digestion and feeds in detail.

1. Major Systems of Domestic Animals (1.0 h) *review the systems introduced in Unit 10.2. Do not treat them in detail at this time.*	
2. Nutrients and Their Uses (2.0 h) *proteins, carbohydrates, fats, vitamins, minerals and water.*	ACTIVITY: Performing qualitative tests for nutrients in feeds.
3. Types of Digestive Systems (1.5 h) *animals as converters; comparison of the systems of ruminants (e.g., cow), non-ruminants (e.g., pig), fibre converters (e.g., horse) and poultry.*	ACTIVITY: Examination of a ruminant stomach (e.g., sheep).
4. Digestion and Assimilation of Food (1.0 h) *physical processes; chemical digestion; absorption; assimilation.*	ACTIVITY: Determining the effects of amylase and hydrochloric acid on starch.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Feeding Terms (2.0 h) *ration; balanced ration; concentrate; supplement; roughage; TDN; crude protein; digestible protein; Pearson's square; least -cost ratio; net energy.*	ACTIVITY: Investigation of labels from commercial feeds and concentrates.
6. Types of Feeds (2.5 h) *pasture or range; hay; silage; carbohydrate concentrate; protein concentrate; less common feeds (root crops, dairy by-products, milling and distilling industry by-products, garbage and artificial feeds such as urea); antibiotics, tranquilizers and hormones.*	ACTIVITY: Examination of samples of a variety of feeds.
7. Feeding Tables and Their Use (1.5 h) *choice of feed; simple rations.*	ACTIVITY: Using feeding tables.
8. Regulation and Labelling of Feeds (0.5 h)	
9. Review and Evaluation (2.0 h)	

UNIT A.3 DOMESTIC ANIMALS III

This unit deals with the use of domestic animals for food. It includes introductory material on management, housing and health problems (diseases). Note that housing receives detailed treatment in Units B.5 and B.6 (Agricultural Engineering). Note also that diseases receive detailed treatment in Units B.9 and B.10 (Microbiology).

NOTES:

a) Under "Special Management" you could discuss exercise, proper nutrition, environmental stresses and transportation.

b) Under "Housing" you could discuss purposes, types (stall and loose), problems with design, ventilation, heating and sanitation, manure handling systems, sewage lagoons and sewage irrigation.

c) Under "Health Problems" you could identify types of diseases (viral, bacterial, fungal, inherited) and discuss common diseases such as mastitis, brucellosis, tuberculosis, rabies, scours, bloat, milk fever, foot and mouth, and foot rot. You could also deal with special health problems associated with pregnancy and birth, castration and vitamin deficiencies.

1. Types and Breeds of Domestic Animals (1.0 h) *dairy cattle; beef cattle; pigs; sheep; horses; poultry.*	ACTIVITY: Field trip to a spring or fall fair. ACTIVITY: Identification of main breeds of domestic animals. Consult Agriculture Canada, the Ministry of Agriculture and Food, your local Ag. Rep. and the Univ. of Guelph for resources.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
2. The Dairy Industry (2.5 h) *milk production (the udder); milk composition; dairy products and production methods; quality control (IRMA and Babcock test); feeds and feeding; special management; housing; health problems; record of performance (ROP); Dairy Herd Improvement Association; marketing.*	ACTIVITY: Determining the fat content of milk. ACTIVITY: Trace the history of the Ontario Milk Marketing Bd. (OMMB).
3. The Beef Industry (2.5 h) *methods of beef production; marketing classes; slaughtering; grading systems; beef cuts; feeds and feeding; special management; housing; health problems; marketing.*	ACTIVITY: Identification of beef cuts. Consult the Beef Marketing Board or your Ag. Rep. for resources.
4. The Pig (Swine) Industry (2.0 h) *pork production; types of hog operations; marketing trends; live animal evaluation; cuts of pork; feeds and feeding; special management; housing; health problems.*	ACTIVITY: Identification of pork cuts. Consult the Pork Producer's Association or your Ag. Rep. for resources. FILMSTRIP: Swine Management Series (VEP) - 3 parts
5. The Sheep Industry (1.0 h) *mutton production; wool and mohair production; feeds and feeding; special management; housing; health problems.*	FILMSTRIP: Sheep Management (VEP) - 5 parts
6. The Horse Industry (1.0 h) *uses; feeds and feeding; special management; housing; health problems.*	ACTIVITY: Identification of the characteristics of draught, riding and racing horses.
7. The Poultry Industry (2.0 h) *meat production; egg production; feeds and feeding; special management; housing; health problems; marketing.*	ACTIVITY: Laboratory comparison of feeds for laying hens and broilers. FILMSTRIP: Poultry Selection and Judging (VEP) - 2 parts
8. Review and Evaluation (2.0 h)	

UNIT A.4 DOMESTIC ANIMALS IV

This unit provides students with sufficient knowledge of Mendelian genetics that they can understand the reproduction of mammals and poultry and the science of animal breeding.

You may wish to teach this unit concurrently with Unit 12.3 (Plant Science III) because of the overlap of the material on Mendelian genetics.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Mendelian Genetics (2.0 h) *Mendel's experiments; hybridization; dominant and recessive genes; monohybrid and dihybrid crosses; Law of Dominance; Law of Segregation; phenotype and genotype; multiple alleles.*	SOUND-SLIDE: Genetics - Observing Patterns in Inheritance (S&M)
2. Animal Mitosis and Development (1.5 h) *importance to genetic continuity; phases in mitosis; cell development; growth; differentiation.*	ACTIVITY: Microscopic study of animal mitosis. SOUND-SLIDE: Development in Animals and Plants: It All Starts with DNA (S&M)
3. Animal Meiosis (1.5 h) *chromosome number and structure; genes; homologues; diploid and haploid numbers; genetic variation; adaptations.*	SOUND-SLIDE: Genetics: Observing Patterns of Inheritance (S&M)
4. The Genetic Material (1.5 h) *chromosomes, genes and DNA; meiosis and Mendel's findings; Law of Independent Assortment; sex chromosomes; linkage; chromosomal variations; mutations.*	FILMSTRIP: DNA: The Genetic Code (PH)
5. Reproduction of Mammals (2.0 h) *male and female bovine systems; estrus cycle; hormone interaction and function; spermatogenesis and oögenesis; gestation periods; breeding systems; artificial insemination; pregnancy, labour and birth; suckling the young mammal; weaning; ova transplants.*	ACTIVITY: Microscopic study of sperm and eggs. FILMSTRIP: The Reproduction Kit (VEP)
6. Reproduction of Poultry (2.0 h) *structure and function of egg-laying system; structure of an egg; functions of the parts of an egg; development of the embryo; incubation and hatching.*	ACTIVITY: Embryology studies on fertile chicken eggs. ACTIVITY: Incubation of chicken eggs.
7. Variations (1.5 h) *heredity and environment; Theory of Natural Selection; gene pool; random mating; mutations; meaning of species, subspecies, variety and form; variation in species.*	FILMSTRIP: The Origin of a Species (PH) SOUND-SLIDE: How Life Survives: Adaptation and Evaluation (S&M)
8. Animal Breeding (1.0 h) *purpose; history; selective breeding of superior types; values of animal breeding; problems.*	FILM: Animal Breeding (MFA) ACTIVITY: Field trip to a breeders' association.
9. The Future of Genetics (1.0 h) *cloning; genetic engineering; recombinant DNA.*	
10. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT A.5 HORTICULTURE I	
This unit begins with a study of the types of greenhouses, their structure and the factors that can be controlled by greenhouses. Then, after investigating the needs of plants, this unit proceeds to a study of the manipulation of greenhouse factors in order to achieve the environmental requirements of plants that students may wish to propagate.	
1. Greenhouse Types and Structure (2.0 h) *types (ridge and furrow, single ridge, lean-to, etc.); lighting and shading systems; ventilation systems; heating and cooling systems; bench type and arrangement; watering systems.*	ACTIVITY: Introduction to the school greenhouse or an alternative growing system such as a growth chamber, plant mobile centre or plastic shelter. FILMSTRIP: Greenhouse Maintenance (VEP)
2. Basic Plant Needs (1.0 h) *temperature; light; oxygen; carbon dioxide; water; minerals; humidity.*	FILMSTRIP: Growing Media for Ornamental Plants (VEP)
3. Greenhouse Soils (2.5 h) *sterilization; nutrient tests; soil mixes; artificial media; pH tests. (Note: Though "sterilization" is in common usage, "pasteurization" is a better term to use.)*	ACTIVITY: Sterilization of soil. ACTIVITY: Preparation of soil mixes. ACTIVITY: Testing the pH and nutrient levels of soil.
4. Fertilizers (1.0 h) *types (liquid, solid and slow release); application procedures; effects of deficiencies; effects of overuse.*	FILMSTRIP: How to Fertilize Greenhouse Plants (PH)
5. Disease and Pest Control (1.5 h) *pesticides for greenhouse use; safe handling; biological pest control.*	ACTIVITY: Examination of pesticide labels. FILMSTRIP: How to Recognize and Control Common Greenhouse Pests (PH)
6. Containers (0.5 h) *types of pots, flats and paks; advantages, disadvantages and proper use of each type.*	ACTIVITY: Preparation of pots, flats and paks for seeding. ACTIVITY: Determining the structure of a seed.
7. Bedding Plant Production (4.5 h) *sexual reproduction; structure of seeds; life span of seeds; dormancy; seed preparation techniques such as scarification; sowing of seeds; conditions for germination; care of seedlings; damping off; hardening off; transplanting techniques; care of transplants; the cold frame.*	FILMSTRIP: How to Plant Seedlings (PH) ACTIVITY: Sowing of seeds and care of seedlings. ACTIVITY: Transplanting of seedlings and care of transplants. FILMSTRIP: How to Transplant Seedlings into Flats (PH) FILMSTRIP: Bedding Plant Production (VEP)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
8. Horticulture as an Occupation (0.5 h) *the greenhouse industry in Canada; scope of horticulture; job opportunities.* 9. Why Horticulture? (0.5 h) *food production; aesthetics; recreation; beautification of real estate.* 10. Review and Evaluation (2.0 h)	FILMSTRIP: How to Transplant Seedlings from Flats to Pots (PH) FILMSTRIP: How to Water Greenhouse Plants (PH)

UNIT A.6 HORTICULTURE III

This unit builds upon the skills and knowledge the students have acquired in Unit A.5. Studies in bedding plant production are continued in order that students may refine their techniques. Then asexual methods of plant propagation are investigated.

1. Germination and Viability of Seeds (1.5 h) *percent germination; viability of seeds.*	FILMSTRIP: How to Perfom Germination and Viability Tests on Seeds (PH) ACTIVITY: Determination of Percent Germination. ACTIVITY: Performing the tetrazolium colour test for viability.
2. Bedding Plant Production (3.0 h) *a continuation of Section 7 of Unit A.5, Horticulture I. Students should try different species, soil mixes and techniques.*	ACTIVITY: Sowing of seeds and care of seedlings. ACTIVITY: Transplanting of seedlings and care of transplants.
3. Vegetative Plant Propagation (1.0 h) *asexual reproduction; importance of plant propagation; advantages and disadvantages to plant species of sexual and asexual reproduction.*	FILM: Why Price Beauty? (NFB) FILMSTRIP: Propagating Ornamental Plants (VEP)
4. Plant Propagation by Cuttings (3.0 h) *cuttings from underground stems; cuttings from aboveground stems; softwood cuttings; hardwood cuttings; use of rooting hormones; use of mist beds.*	ACTIVITY: Preparation and care of plant cuttings. FILM: Plant Propagation: From Seed to Tissue Culture (MAC)
5. Plant Propagation by Division (0.5 h) *root division; underground stem division.*	TEACHER DEMONSTRATION: Division of roots and underground stems.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Plant Propagation by Grafting (1.5 h) *compatible scions and stocks; types of grafts; procedures; care of grafted plants; values of grafting.*	ACTIVITY: Performing a graft and caring for the resulting plant.
7. Plant Propagation by Budding (1.5 h) *compatible buds and stocks; procedures; care of resulting plants.*	ACTIVITY: Performing propagation by budding.
8. Plant Propagation by Layering (2.0 h) *suitable species; techniques (simple, air, trench, mounding, serpentine, tipping).*	ACTIVITY: Propagating plants by one or more methods of layering.
9. Review and Evaluation (2.0 h)	

UNIT A.7 HORTICULTURE III

The basic techniques of plant propagation and care were established in Units A.5 and A.6. Now students refine their knowledge of those techniques by studying the special problems associated with the propagation and care of annuals, biennials and perennials. In addition, the production of food producing bedding plants is investigated.

1. Common House and Garden Plants (2.5 h) *students should collect and share data on about 20 plants: identification, soil, watering, fertilizing, light, humidity, temperature, pruning, pest and disease control, planting techniques, containers.*	ACTIVITY: Tabulate data on the identification, propagation, care and uses of several common house plants and garden plants. FILMSTRIP: Fertilizing Ornamental Plants (VEP)
2. Annuals (3.0 h) *identification; uses; location (shade or sun); selection (height, colour, shape); indoor starting time and conditions; hardening off; transplanting outside; summer care.*	ACTIVITY: Propagation and care of common annual plants such as marigold, petunia, *Celosia, Salvia, Cloeme, Alyssum* and *Ageratum.* FILMSTRIP: Plant Identificatio (VEP)
3. Biennials (1.0 h) *identification; comparison with annuals; uses; special care problems.*	
4. Perennials (3.0 h) *identification; comparison with annuals; propagation by seed and asexual methods; location; selection; soil preparation; summer care; staking; winter protection.*	ACTIVITY: Propagation and care of common perennials such as delphinium, phlox, iris, peony and lupin.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Food Producing Bedding Plants (3.0 h) *propagation and care of tomato, cabbage, brocolli, cantelope, watermelon, pepper and other common food producing plants with a long growth time.*	ACTIVITY: Growing cabbage, brocolli, tomato and other food producing plants from seed to the hardening off stage.
6. Review and Evaluation (2.0 h)	

UNIT A.8 HORTICULTURE IV

The emphasis in this unit is upon commercial greenhouse and nursery operations. Students investigate the operation of a commercial greenhouse and then simulate part of the operation by growing two or three specialty greenhouse crops. (The growth of these specialty plants will have to be spread throughout the year. The time schedule allows you to do just two of Sections 2 to 5.) Students also investigate the operation of a commercial nursery and then simulate part of the operation by propagating shrubs by cuttings and by transplanting, pruning and caring for some shrubs and trees.

1. The Greenhouse Industry (2.0 h) *importance; scope of horticulture; job opportunities; capital investment; seasonal changes in output.*	ACTIVITY: Field trip to a local commercial greenhouse. FILM: Planting and Transplanting at the Brooklyn Botanical Garden (MAC)
2. Dutch Bulbs (3.0 h) *origin; commercial production areas; culture requirements; structure of a bulb and a corm; indoor forcing (time of year, potting techniques and forcing conditions); outdoor culture (time of year, planting depth, grouping, etc.); propagation; commercial importance.*	ACTIVITY: Determining the structure of a bulb (e.g., tulip) and a corm (e.g., crocus). ACTIVITY: Indoor forcing of bulbs and corms. ACTIVITY: Preparing a bed of Dutch bulbs and corms.
3. Easter Lily (3.0 h) *origin, history and characteristics; potting time and techniques; precooling; growing schedule; height control with growth regulators; use of photoperiod; commercial importance.*	ACTIVITY: Growth of Easter lilies.
4. Poinsettia (3.0 h) *origin, history and characteristics; factors affecting planting date; planting techniques; use of photoperiod; pinching (purpose and types); commercial importance.*	ACTIVITY: Growth of poinsettias, including experiments with growth retardants, pinching, lighting, feeding and watering.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Chrysanthemum (3.0 h) *origin, history and characteristics; types (standard, spray, etc.); planting techniques; use of photoperiod; use of temperature control; pinching and disbudding; cutting selection and grading; commercial importance.*	ACTIVITY: Growth of chrysanthemums. FILMSTRIP: Care and Handling of Cut Flowers and Foliage (VEP) ACTIVITY: Field trip to a florist.
6. Cut Flowers (1.0 h) *cutting techniques; care; floral arrangements.*	
7. The Nursery Industry (2.0 h) *importance, scope; job opportunities; seasonal changes in output.*	ACTIVITY: Field trip to a nursery.
8. Types of Nursery Plants (2.0 h) *bedding plants; perennial stock; shrubs; hedge plants; fruit trees; evergreen trees; deciduous trees (shade and ornamental); growth and care of nursery plants.*	ACTIVITY: Growth of shrubs from cuttings (e.g., *Euonymus*, alpine currant and juniper.)
9. Transporting and Transplanting of Nursery Stock (2.0 h) *root pruning (functions and techniques); twig pruning; ball and burlap method; container method; transplanting times; transplanting techniques; winter care.*	ACTIVITY: Planting and care of trees and shrubs on the school property.
10. Review and Evaluation (2.0 h)	

UNIT A.9 LANDSCAPING I

This introduction to landscaping develops the functions of landscaping and introduces students to the basic design principles and plants that are used to create the living component of a landscaped area.

1. Functions of Landscaping (1.0 h) *consideration of needs and objectives; history of landscaping; job opportunities.*	
2. Design Principles (2.5 h) *styles of design (formal and informal); features controlling design; human factors; areas (private, public and service); considerations (balance, plant groupings, distance from foundation, spacing of plants, colour, texture, problem areas. framing, contrast, harmony, repetition, variety, simplicity, sequence); symbols used; sketching; drafting; use of scale.*	FILM: New Ideas in Landscape Design (MAF) ACTIVITY: Field trip to a well-designed landscape. FILM: Design for a Garden (IFB)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
3. Common Landscaping Plants (2.5 h) *identification of common lawn grasses, shade trees, ornamental trees, flowering shrubs, evergreen trees and shrubs, roses, bulbs, hedges, vines and ground covers.*	ACTIVITY: Walking tour of the neighbourhood to identify common landscaping plants.
4. Site Analysis (1.0 h) *setting (topography, drainage, water supply); orientation (wind, sun); soil (depth, texture).*	ACTIVITY: Analysis of a local site. ACTIVITY: Study of local property values and the contribution of landscaping through discussions with a real estate person.
5. Criteria for Selection of Landscaping Plants (1.5 h) *plant hardiness zones; climate; light conditions; growth habits; colour; height and spread; building structure.*	ACTIVITY: Investigation of plant hardiness zone maps.
6. Preparation of Landscaping Plans (3.0 h) *use of the knowledge gained in Sections 2 to 5.*	ACTIVITY: Preparation of a landscaping plan for the school or home.
7. Cost Estimation (1.5 h) *use of catalogues to prepare cost estimates for materials; estimation of labour costs.*	ACTIVITY: Preparation of a cost estimate for the implementation of the plan.
8. Review and Evaluation (2.0 h)	

UNIT A.10 LANDSCAPING II

In this unit students continue their application of the design principles learned in Unit A.9. In addition, students learn how to incorporate into their landscaping plans physical alteration of the environment with such things as patios and rockeries.

1. Physical Alteration of the Landscape (4.0 h) *the design of patios, foundations, walkways, rockeries, steps, driveways, arbours and retaining walls.*	ACTIVITY: Walking tour of the neighbourhood to view physical features of landscaped areas.
2. Preparation of Landscaping Plans (4.0 h) *a combination of the principles learned in Unit A.9 with those learned in Section 1 of this unit.*	ACTIVITY: Preparation of a landscaping plan that includes one or more of the physical alterations of Section 1.
3. Cost Estimation (3.0 h) *use of catalogues and telephone calls to suppliers of building materials to prepare cost estimates; estimation of labour costs.*	ACTIVITY: Preparation of a cost estimate for the implementation of the plan.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
4. Landscaping in Natural Areas (1.5 h) *municipal parks; conservation areas; nature trails; campgrounds; provincial parks.*	ACTIVITY: The study of photographs of landscaping in natural areas.
5. Review and Evaluation (2.0 h)	

UNIT A.11 LANDSCAPING III

In this unit students continue their application of the design principles learned in Units A.9 and A.10. In addition, students begin their study of the maintenance of landscapes. The emphasis in this unit is on lawns and foundation plants.

1. Preparation of Landscaping Plans (3.0 h) *the special problems of large buildings such as office buildings, commercial buildings and churches; the special problems of new buildings.*	ACTIVITY: Preparation of a landscaping plan for a large building or a new building.
2. Cost Estimation (2.5 h) *preparation of cost estimates, including plants, physical materials and labour; acceptable format for the estimate.*	ACTIVITY: Preparation of a cost estimate for the plan.
3. Planting a New Lawn (2.5 h) *types of grasses and their characteristics; preparation of the seedbed; sowing grass seed; care during germination; care of the young lawn; sodding.*	ACTIVITY: Planting and maintenance of a small plot of new grass. FILMSTRIP: Lawns and Ground Covers (VEP)
4. Lawn Maintenance (2.5 h) *mowing; fertilizing; watering; mulching; rolling; weed control; disease control; rehabilitation of bare spots; use of composting.*	ACTIVITY: Maintenance of the school lawn as a class project.
5. Maintenance of Foundation Plants (2.5 h) *planning and maintaining a focal point; soil preparation; mulching; fertilizing; watering; pest and disease control; pruning; winter maintenance.*	ACTIVITY: Maintenance of the school foundation plantings as a class project.
6. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT A.12 LANDSCAPING IV In this unit students continue their study of the maintenance of landscapes. The emphasis here is on trees, shrubs and hedges. In addition, students learn how to landscape the area around farm buildings and how to landscape for wildlife.	
1. Maintenance of Trees (3.0 h) *choice and placement of species based on aesthetics; choice and placement of species to assist in energy conservation in the home; planting procedures; fertilizing; watering; disease control; pruning; wound repairs.*	ACTIVITY: Selection of species to landscape a given site. ACTIVITY: Maintenance of trees on the school property as a class project. FILMSTRIP: Elements of Pruning (VEP)
2. Maintenance of Shrubs (3.0 h) *evergreen and deciduous shrubs; choice and placement of species; planting procedures; fertilizing; watering; pruning; disease control; winter care.*	ACTIVITY: Maintenance of shrubs on the school property as a class project.
3. Maintenance of Hedges (3.0 h) *functions of hedges; evergreen and deciduous hedges; choice of species; planting procedures; fertilizing; watering; disease control; desirable shapes; pruning; shearing.*	ACTIVITY: Planting and maintenance of a functional hedge on the school property.
4. Landscaping Around Farm Buildings (2.0 h) *functions (wind control; privacy; aesthetics); tree species for wind control; planting to control snow drifting; landscaping the farm house; landscaping the farm lane.*	ACTIVITY: Preparation of a landscaping plan for a farm.
5. Landscaping for Wildlife (2.0 h) *functions (habitat, nesting sites, shelter, food); selection and arrangement of species.*	ACTIVITY: Preparation of a landscaping plan to attract wildlife (particularly birds).
6. Review and Evaluation (2.0 h)	ACTIVITY: Participation in an "Arbor Day" event.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES

UNIT B.1 AGRIBUSINESS I

The purpose of this unit is to prepare students for the business aspect of farm management. The students learn how to keep records, prepare income tax returns, manage finances and plan for the future.

1. The Need for Records (1.5 h) *cost of producing some common foods (loaf of bread, kilogram of beef, litre of milk); potential income from producing such foods; profit-loss considerations; need for records.*	
2. Record Keeping (1.0 h) *types of record systems (cash or accrual method of records; basic records for income tax purposes; inventory records).*	ACTIVITY: Examination of a variety of farm record books. FILM: The Business of Farming (NFB)
3. Receipts and Expenses (3.0 h) *farm receipts; farm expenses; statement of farm income and expenses; managing the checking account; accounts payable.*	ACTIVITY: Preparing a statement of farm income and expenses for a hypothetical farm operation.
4. Managing Large Sums of Money (4.0 h) *credit and installment buying; capital cost allowance, income averaging; livestock inventory provisions; short-term and long-term investments; transferring a family farm to the next generation.*	ACTIVITY: Calculating the monthly payments on a number of large credit purchases. ACTIVITY: Determining the capital cost allowance for a major piece of equipment.
5. Balance Sheet and Income Tax (3.0 h) *development of a balance sheet; purpose of a balance sheet; income tax returns; records needed for talking to a banker.*	ACTIVITY: Preparation of a balance sheet.
6. Review and Evaluation (2.0 h)	ACTIVITY: Study of farm income tax forms. ACTIVITY: Discussion with a local banker.

UNIT B.2 AGRIBUSINESS II

The purpose of this unit is to familiarize students with the major off-farm influences that affect farm income and expenses. The teacher should emphasize that the successful farmer monitors these influences on a regular basis.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Supply and Demand (3.0 h) *supply and demand curves; price cycles; consumer demand for food; role of production; beef price cycle; hog price cycle.*	ACTIVITY: Plotting of supply and demand curves from data. FILM: Agriculture Canada (NFB)
2. Marketing of Farm Products (2.0 h) *history of farm marketing boards; Ontario Milk Marketing Board; Ontario Pork Products Marketing Board; marketing of eggs and poultry; marketing of grain crops.*	ACTIVITY: Field trip to a distribution centre such as the stockyards or a food terminal. FILMSTRIP: Agriculture in Canada (PH)
3. The Quota System (2.0 h) *functions; method of operation; the quota systems for milk, poultry and eggs; effects of the lack of a quota system on beef and pork production and prices.*	ACTIVITY: Debate on the pros and cons of implementing quotas on hog and beef production.
4. Sources of Information for Farmers (2.0 h) *stockyard reports (radio); farm magazines such as* Country Guide, Farm and Country, Report on Farming, Cattlemen, and The Hog Market Quarterly*;* CanFarm*;* Agricultural Statistics; OMAF Fact Sheets.	ACTIVITY: Monitoring stockyard reports for several weeks to collect data on the relationship between supply and price. ACTIVITY: Examination of a variety of farm magazines.
5. The Future of Agriculture in Canada (3.0 h) *positive aspects of farming as an occupation; negative aspects; the decline in the number of farms and farmers; farming as an occupation in the future; other careers in agriculture; obtaining an education in agriculture; the shift from family to corporation-run farms.*	FILM: Where Have All the Farms Gone? (NFB) FILM: Following the Plough (NFB) FILM: Potatoes (NFB) FILM: Waterloo Farmers (NFB)
6. Review and Evaluation (2.0 h)	

UNIT B.3 AGRICULTURE CROP SCIENCE I

This unit investigates the major agricultural crops in Canada. By the end of the unit, the students should be able to recognize these crops, state where they are grown and discuss their importance to Canadians and the world community. This unit is suitable for both rural and urban students.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Cereal Crops (3.5 h) *identification of wheat, oats, barley and corn, both as seed and in the field; products derived from these crops; major producing areas in Canada; major producing countries in the world; yields per hectare in various parts of Canada; economic importance.*	FILM: Wheat (NFB) ACTIVITY: Examination of samples of several grains (seeds and plants). ACTIVITY: Viewing of prints or slides of standing cereal crops.
2. Forage Crops (2.5 h) *identification and use of legumes such as alfalfa, red clover and bird's foot trefoil; identification of grasses such as timothy, orchard grass and brome grass; permanent pasture; use of legumes in crop rotation; production, storage and use of ensilage.*	ACTIVITY: Examination of several legumes and grasses. ACTIVITY: Examination of ensilage samples. SLIDE SET: Crop Seed Identification
3. Fruit Crops (2.0 h) *identification of fruit trees such as apple, pear, peach, plum and cherry; major producing areas in Canada; climate as a factor in yield determination; the conflict between fruit growing and urban sprawl; economic importance.*	FILM: An Apple for All Seasons (NFB) ACTIVITY: Case studies on the disappearance of fruitlands. FILM: Niagara for Sale (NFB)
4. Oil Crops (2.0 h) *identification and uses of linseed, flax, soybean, rape and sunflower; major producing areas in Canada; yield per hectare in various parts of Canada; economic importance.*	ACTIVITY: Examination of samples of several oil crops. ACTIVITY: Examination of products from oil crops.
5. Vegetable Crops (1.0 h) *beans, peas, corn, soybeans, potatoes, tomatoes, etc.; major producing areas in Canada; economic importance.*	
6. Recent Advances in Crop Science (2.0 h) *importance of new hybrids (particularly corn, other grains and soybeans); new crops in Ontario (soybeans and sunflowers); blueberries; peanuts.*	ACTIVITY: Discussion of data on low heat unit varieties of corn and soybeans. ACTIVITY: Examination of a map of Ontario's heat unit areas.
7. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT B.4 AGRICULTURAL CROP SCIENCE II This unit deals with field management practices and has been designed primarily for rural students. Three or four major crops should be dealt with under each of the section headings of this unit. One of these should be a well established crop such as corn. Another should be a relatively new crop such as soybeans.	
1. Seedbed Preparation (2.5 h) *tillage equipment; tillage practices; preplanting fertilization and pesticide application; soil testing.*	FILMSTRIP: Soybean Production (BPI) - 5 parts FILMSTRIP: Techniques in Land Preparation (VEP) ACTIVITY: Field trip to an equipment dealer. FILMSTRIP: Corn Production (BPI) - 10 parts
2. Planting Methods (2.5 h) *equipment; time of year; spacing techniques and patterns; crop rotation (advantages and examples); non-tillage seeding.*	FILMSTRIP: Tractor Operation and Safety (BPI) - 4 parts
3. Weed Control (2.0 h) *life cycles of common weeds; harmful effects of weeds; how weeds are spread; identification of common weeds; herbicides; proper use of herbicides; environmental and health problems with herbicides; cultivation for weed control.*	FILMSTRIP: Pesticides: Safe Handling and Use (BPI) - 6 parts SLIDE SET: Agricultural Weed Identification Slide Set (VEP) FILMSTRIP: Agricultural Weed Control (VEP)
4. Harvesting (2.0 h) *equipment; methods.*	FILM: Harvesting (NFB) FILM: Wheat (NFB)
5. Storage (1.5 h) *methods and facilities; moisture content tests.*	ACTIVITY: Determination of the moisture content of grain and legume samples.
6. Marketing (1.0 h) *refer to Unit B.2, Section 2.*	
7. Monoculture Crops (1.5 h) *advantages and disadvantages of growing a single crop on a field for many years; alternatives.*	ACTIVITY: Visit from the agricultural representative to discuss the effects of long term monoculture crops.
8. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT B.5 AGRICULTURAL ENGINEERING I	
This unit deals with the maintenance, uses and safe operation of farm machinery. You may wish to extend some of this material into Unit B.6.	
1. Small Engine Maintenance (3.0 h) *2-cycle and 4-cycle engines; internal structure; tuneup; maintenance of fuel, airflow, electrical, lubrication and cooling systems.*	FILMSTRIP: Small Engines Explained (BPI) - 9 parts ACTIVITY: Disassembly and assembly of a small engine. ACTIVITY: Giving a small engine a minor tuneup.
2. Tractors and their Maintenance (5.0 h) *identification and unique features of major makes of tractors; power ratings required for various jobs; power rating and fuel consumption; diesel versus gasoline engines; turbochargers; manual versus hydrostatic transmissions; maintenance of fuel, airflow, lubrication, electrical, braking, clutch, cooling and hydraulic systems; tire care; PTO care; safe operation of tractors.*	FILMSTRIP: Tractor Operation and Safety (BPI) ACTIVITY: Comparison of data on a selection of tractor makes and models using brochures from dealers. ACTIVITY: Selecting the proper tractor for the job. ACTIVITY: Examination of new and used air, oil and fuel filters. ACTIVITY: Maintenance of a tractor.
3. Levers, Pulleys and Gears (2.5 h) *the three classes of levers; mechanical advantage; uses of levers on the farm; fixed and movable pulleys; uses of pulleys on the farm; structure and uses of gears; gear ratio.*	ACTIVITY: Laboratory studies of the three classes of levers. ACTIVITY: Laboratory studies of fixed and movable pulleys.
4. Tillage Implements and Their Maintenance (2.5 h) *advantages and disadvantages of fully mounted, semi-mounted, trailing and 2-way moldboard ploughs; selection of bottom width and number of bottoms; variable width bottoms; automatic reset; matching the plough and tractor; chisel ploughs; functions of other tillage equipment such as cultivators, disc harrows and packers; maintenance of tillage equipment.*	ACTIVITY: Study of data on tillage equipment using brochures from dealers. ACTIVITY: Field trip to an implement dealer or a farm implement exposition.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Planting Implements and Their Maintenance (1.5 h) *features and maintenance of corn planters and other seed drills (or select other planters for common crops in your area).*	ACTIVITY: Study of the effects of damp fertilizer on metals.
6. Harvesting Implements and Their Maintenance (1.0 h) *a general survey of swathers, combines, forage harvesters, balers, delivery systems and other harvesting equipment.*	
7. Review and Evaluation (2.0 h)	

UNIT B.6 AGRICULTURAL ENGINEERING II

You may wish to use part of the time allotted for this unit to continue the study of farm machinery initiated in Unit B.5. However, if you know that some of your students may become involved in confinement housing of livestock, you should devote most of your time to the topics of this unit.

1. Building Construction for Swine and Beef Confinement (3.5 h) *site selection; size; materials; sketch plans; critical path analysis; costing and contracting.*	ACTIVITY: Discussions with a visiting agricultural engineer.
2. Manure Handling Systems (3.5 h) *solid, semi-solid and liquid systems; aerobic and anaerobic fermentation; slat and pit confinement; cesspools; aerobic flush; lagoons; transportation and irrigation systems; safety precautions; possible environmental problems.*	ACTIVITY: Preparation of sketch plans of a building for a beef or pork operation of a given size.
3. Environmental Control Systems (3.0 h) *ventilation systems; the heat balance problem; ventilation and heating recommendations for livestock; types of fans and their control; air distribution; supplemental heating; monitoring and warning systems.*	ACTIVITY: Field trip to local farm with a variety of manure handling systems and environmental control systems. ACTIVITY; Study of photographs of a variety of buildings (provided by a building contractor).

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
4. Dairy and Poultry Operations (2.5 h) *treat these as you did swine and beef operations if a need exists in your area.*	
5. Review and Evaluation (2.0 h)	

UNIT B.7 FORESTRY I

In this unit students learn to identify important tree species and the common characteristics of trees. Then they investigate forest ecology and the distribution of forest regions in Canada. Finally, they study the importance of forests and the factors that affect the quality and abundance of trees in the forests.

1. Tree Identification (2.5 h) *nomenclature and classification of trees; identification of major coniferous and deciduous trees; use of dichotomous keys; use of winter twigs for identification.*	ACTIVITY: Identification of conifers from twig and cone specimens. ACTIVITY: Identification of deciduous trees using leaves. ACTIVITY: Identification of deciduous trees using winter twigs.
2. Structure of a Tree (1.5 h) *main parts (crown, trunk and root); structure of a stem (bark, sapwood, heartwood, springwood and summerwood); leaf terminology; functions of leaves; hardwood and softwood; reproduction of trees; growth (regions and characteristics).*	ACTIVITY: Examination of cross-sections of tree trunks. ACTIVITY: Classification of wood samples as hardwood or softwood.
3. Forest Geography (2.0 h) *forest regions of Canada; dominant species in each region; climatic factors; topographical factors.*	ACTIVITY: Study of a map of the forest regions of Canada. FILM: Forest Regions of Canada (NFB)
4. Forest Ecology (2.0 h) *structure of a forest ecosystem (abiotic and biotic); forest succession; forest fires and succession; regeneration; importance values of trees.*	FILM: Life in the Woodlot (NFB) ACTIVITY: Field trip to find the importance values of tree species in a woodlot or forest using the quadrat method.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Importance of Forests (2.0 h) *economic (historical and modern); recreational; asethetic; ecological; ranking of Canada's forests in the world situation; Ontario's contribution; forest area and volume.*	ACTIVITY: A survey of the community to determine the extent to which local jobs depend on forests (e.g. lumber yards, use of paper products). FILM: The Forest (NFB)
6. Forest Pests and Diseases (2.0 h) *main insect pests and the harm they do (spruce budworm, larch sawfly, forest tent caterpillar, white pine weevil, balsam wooly aphid, Douglas fir beetle, European pine sawfly and European pine shoot moth); main diseases and the harm they do (decay organisms, Dutch elm disease, white pine blister rust, armillaria root rot, canker of aspen); dangers of monocultures.*	FILM: The Spruce Bog (NFB) FILMSTRIP: The Deciduous Forest (PH) ACTIVITY: Identification of common insect pests and the damage they do.
7. Forest Fires (1.0 h) *causes; damage done; positive features.*	
8. Review and Evaluation (2.0 h)	

UNIT B.8 FORESTRY II

The major focus of this unit is the forest industry. You should stress throughout this unit the need for a balance between forest utilization on the one hand and forest management, regeneration and protection on the other.

1. Logging and Utilization (2.5 h) *logging methods; wood delivery; complete utilization techniques; saw mills; pulp and paper operations; Christmas tree production; measurement of crop.*	FILM: The Renewable Tree (TL) FILMSTRIP: Canada's Forest Industries (PH) ACTIVITY: Visit to a saw mill and/or pulp and paper operation.
2. Forest Management (2.0 h) *techniques; sustained yield; renewable resources; government responsibilities; industry responsibilities; management plans; issues in management.*	FILM: Forest Highways (NFB) ACTIVITY: Timber estimating by cruising. FILM: The Lorax ( )

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
3. Silviculture (2.0 h) *natural regeneration; artificial regeneration; tree nurseries; silvicultural characteristics of species; succession; followup management (thinning, pruning, protection).*	FILM: Tree Improvement and Genetics (IFB) FILM: The Forest Watchers (NFB) ACTIVITY: Visit to a tree nursery. ACTIVITY: Thinning of a reforested area.
4. Forest Protection (3.0 h) *insect protection (life cycles and control methods for insects in Section 6 of Unit B.7; disease protection (control methods for diseases in Section 6 of Unit B.7; ecological effects of disease control methods; fire protection (prevention, detection, climatic factors, control methods).*	FILM: Another Side of the Forest (NFB) ACTIVITY: Case study on the pros and cons of forest spraying. FILM: Aircraft in Fire Control (NFB)
5. Public and Private Forests (1.0 h) *extent of private holdings; contribution to economy; individual responsibility for forest management; Woodlands Improvement Act (W.I.A.).*	ACTIVITY: Visit from a forest technician or forester. FILM: New Man in the Forest (IFB)
6. The Farm Woodlot (1.0 h) *importance (economic and ecological); desirable characteristics; management; role of Ministry of Natural Resources.*	ACTIVITY: Preparation of plans for a nature trail in a local woodlot or forest. FILMSTRIP: Trail Layout and Construction (VEP)
7. Multiple Use Management (1.0 h) *uses of forests and woodlots; managing for wildlife; managing for erosion control; maintaining hiking and nature trails.*	ACTIVITY: Tree planting for the conservation authority and followup maintenance.
8. Acid Precipitation and Forests (1.0 h) *nature and sources of acid precipitation; effects on lakes, soils and plants; sensitive areas in Canada; projected harm to forests; solutions to the problem.*	FILM: Forests Forever (OFIA)
9. Forests for the Future? (1.0 h) *balancing supply and demand in our society; new advances in forest management; importance of recycling of forest products.*	
10. Review and Evaluation (2.0 h)	

UNIT B.9 MICROBIOLOGY I

This unit is an introduction to microbiology. It outlines the scope of this field of biology and provides the basic skills and knowledge required for the applied microbiology in Unit B.10.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Nature of Microbiology (0.5 h) *history; scope; future.*	
2. Microbiological Techniques (1.5 h) *media and their preparation; aseptic techniques; sterilization of equipment; culture plate preparation; sample transfer; incubation; counting methods; safety precautions.*	
3. Monerans (3.0 h) *characteristics; characteristics of blue-green algae; importance of blue-green algae; characteristics of bacteria; structure and classification of bacteria; preparation of culture media; obtaining and transferring pure cultures; safety precautions; gram-stain; motility and growth; dilution techniques; life processes of bacteria.*	ACTIVITY: Examination of blue-green algae. ACTIVITY: Examination of bacteria (oil immersion). ACTIVITY: Preparation of a culture plate.
4. Fungi: Yeasts (3.0 h) *cell structure; isolation from various sources; special growth media; staining; importance.*	ACTIVITY: Isolation and culture of yeasts. ACTIVITY: Examination of yeast cells. ACTIVITY: Yeast respiration.
5. Fungi: Moulds (2.0 h) *main phyla and their characteristics; isolation from various sources; importance.*	ACTIVITY: Isolation and culture of moulds. ACTIVITY: Examination of bread mould.
6. Protists: Protozoans (1.5 h) *main phyla and their characteristics; importance.*	FILM: Protists: Threshold of Life (NG) ACTIVITY: Examination of a mixed protozoan culture. FILM: The Single-Celled Animals - Protozoa (EBE)
7. Protists: Algae (1.5 h) *main phyla and their characteristics; importance.*	ACTIVITY: Examination of a variety of algal protists.
8. Viruses (1.0 h) *nature; structure and composition; viral invasion of host cells; viral reproduction; importance.*	
9. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT B.10 MICROBIOLOGY II	
In this unit students apply the knowledge and skills gained in Unit B.9 to such fields as water and waste water analysis, food and dairy microbiology, soil microbiology and diseases of humans and domestic animals.	
1. Microbiological Analysis of Water and Waste Water 2.5 h) *total bacteria; total coliforms; fecal coliforms; acceptable levels for swimming and drinking; plate methods; membrane filtration; Millipore tabs.*	ACTIVITY: Determination of total bacteria, total coliforms and fecal coliforms in water samples. ACTIVITY: Study of "Microbiology in Relation to Agriculture" (Ontario Ministry of Agriculture and Food)
2. Industrial Uses of Bacteria (1.5 h) *production of dairy products, ensilage, and vinegar; tanning of leather.*	
3. Bacteria and Food Spoilage (2.0 h) *food spoilage; Staphylococcus food poisoning; botulism; Salmonella poisoning.*	ACTIVITY: Isolation and culture of bacteria in food and dairy products.
4. Control of Food Spoilage (1.5 h) *pasteurization; refrigeration; freezing; dehydration; canning; preservatives; radiation; smoking; chlorination and ozonation of water.*	ACTIVITY: Detailed study of one method of controlling food spoilage.
5. Soil Microbiology (3.0 h) *blue-green algae, bacteria and fungi in soil; importance of soil microorganisms; isolation and culture.*	ACTIVITY: Study of soil microorganisms as decomposers. ACTIVITY: Isolation and culture of soil protozoa. ACTIVITY: Isolation and culture of soil bacteria. ACTIVITY: Study of the symbiotic relationship between *Rhizobium* and legumes.
6. Human Diseases and Their Control (2.0 h) *how pathogens harm humans; spread of diseases; defenses against diseases (structural defenses, cellular activity and antibody production); immunity (active and passive); antibiotics; sulfa drugs; disinfectants and antiseptics.*	ACTIVITY: Detailed literature research of a human disease.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
7. Diseases of Domestic Animals (2.0 h) *types (bacterial, fungal, viral, inherited); mastitis; tuberculosis; rabies; milk fever; foot and mouth; foot rot; bloat; scours; brucellosis.* 8. Recent Advances in Microbiology (1.0 h) *synthesis of drugs; cleanup of oil spills.* 9. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT C.1 DIFFERENTIAL LEVELLING This unit provides students with sufficient knowledge of the basic principles of differential levelling (surveying) to permit them to assist in such activities as ditching, drainage, building construction and road construction.	
1. Uses of Differential Levelling (2.0 h) *water control (farm and home drainage, dam construction, ditching); building construction (level, angles, plumb, elevation, property lines); road construction (slopes, drainage, angles, property lines); mapping (elevations, boundaries).*	ACTIVITY: Visit to a drainage, road construction or building construction site. FILMSTRIP: An Exercise in Differential Levelling
2. Terms and Formulas (3.0 h) *need for and definitions of BM, BS, HI, FS, EL and STA; use of $HI = EL + BS$ and $EL = HI - FS$.* *BM = Benchmark* *BS = Backsight* *HI = Height of Instrument* *FS = Foresight* *EL = Elevation* *STA = Station*	ACTIVITY: Construction of a simple surveyor's level such as a transparent garden hose containing water or a mounted carpenter's level. ACTIVITY: Conducting a hill profile study ACTIVITY: Construction of a simple clinometer. ACTIVITY: Determining slope with a clinometer. ACTIVITY: Structure and care of a surveyor's instrument.
3. Use of a Surveyor's Instrument (3.5 h) *need for a level instrument; determining elevations; establishing angles; elevation problems; angle problems; recording data; using the stadia rod.*	ACTIVITY: Conducting simple outdoor elevation projects and angle projects.
4. Application of Surveying Techniques (3.5 h) *student project in which plans are prepared for a drainage system, ditch, property survey or other application.*	ACTIVITY: Preparation of plans for a project using surveying techniques.
5. Careers in Surveying (1.5 h) *skills developed in this unit; job opportunities; further education.*	ACTIVITY: Visit by a local surveyor.
6. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT C.2 DIVERSITY AND CLASSIFICATION OF ORGANISMS	
The identification of organisms during aquatic, terrestrial and soil studies is facilitated if students have an understanding of the system by which organisms are named and classified. If your course involves little field work, your students may need no more knowledge than they already possess from Intermediate Science. However, if field work plays a prominent role in your course, you may want to teach this unit early in the year.	
1. Meaning of Classification (0.5 h) *nature; functions; examples from everyday life.*	
2. Biological Classification (2.0 h) *early systems; the Linnaeus system; binomial nomenclature; genus concept; species concept; main taxa.*	FILMSTRIP: Biology: An Introduction to Classification (BPI)
3. Modern Basis for Classification (1.0 h) *homologous features; similar biochemistry; genetic similarity.*	FILMSTRIP: Biology: An Introduction to the Kingdom Protista (BPI) FILMSTRIP: Biology: The Animal Kingdom (BPI)
4. Classification Systems (1.0 h) *2-kingdom system; 3-kingdom system; 5-kingdom system.*	FILMSTRIP: Kingdom of Plants (NG)
5. Overview of the Five Kingdoms (3.0 h) *a film and laboratory survey of representative organisms from the main phyla of each kingdom.*	ACTIVITY: Classifying an array of organisms into kingdoms and phyla.
6. Classification Keys (4.5 h) *making a dichotomous classification key; using a dichotomous classification key.*	ACTIVITY: Making a dichotomous classification key for deciduous leaves. ACTIVITY: Using dichotomous classification keys to identify aquatic invertebrates to class or order. ACTIVITY: Using a dichotomous classification key to identify conifers to species.
7. Review and Evaluation (2.0 h)	

UNIT C.3 . DOMESTIC WASTES

Domestic wastes are those that originate in homes, offices, schools and stores. In other words, they are "personal" wastes. Most of us are responsible for the production of unnecessarily large quantities of domestic wastes. By reducing this production we can help conserve energy and, in addition, help lessen pollution of air, water and soil. This unit familiarizes students with the problems created by domestic wastes and encourages students to adopt lifestyles that produce less waste.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. What are Domestic Wastes? (0.5 h) *definition; comparison to industrial wastes and agricultural wastes; categories of domestic wastes (sewage wastes and solid wastes).*	
2. Nature of Domestic Sewage (3.0 h) *materials in sewage water (discuss under these headings: water, suspended solids, colloidal material, dissolved material); total coliform and fecal coliform tests and standards for drinking and swimming water; biochemical oxygen demand (BOD).*	ACTIVITY: Determining the total and fecal coliform counts of a water sample. ACTIVITY: Determining the BOD of a water sample. ACTIVITY: Determining the total suspended solids in a water sample. ACTIVITY: Determining the total dissolved solids in a water sample.
3. Sewage Treatment (2.0 h) *pretreatment; primary treatment; secondary treatment; advanced treatment; status of sewage treatment plants in Ontario; disinfection of wastewater; sludge treatment; uses of sludge.*	ACTIVITY: Visit to a sewage treatment plant. ACTIVITY: Study of "Guidelines for Sewage Sludge Utilization on Agricultural Lands"(Ontario Ministries of the Environment and Agriculture and Food)
4. Other Methods of Handling Sewage Wastewater (1.0 h) *sewage lagoons; individual septic systems; the Clivus Multrum system.*	
5. Eutrophication (2.5 h) *definition; effects on lake ecosystems (algal blooms, fish kills); contribution of sewage wastewater to eutrophication; controlling eutrophication (chemical treatment, aeration, harvesting algae, use of wastewater for irrigation, advanced treatment such as phosphate removal).*	ACTIVITY: Studying an algal bloom in a classroom aquarium. FILM: The Great Clean-Up (NFB) FILM: One Man's Garden (NFB)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Nature of Solid Wastes (0.5 h) *definition; average composition of municipal solid waste; magnitude of the problem.*	ACTIVITY: Classification of a week's garbage in the home. FILM: The Garbage Explosion (EBE)
7. Disposal of Solid Wastes (2.0 h) *dumps; sanitary landfill sites; reclamation (recycling); problems of recycling (separation, finding markets); energy production from solid wastes.*	ACTIVITY: Visit to a landfill site and/or a reclamation centre. FILM: Recycled Reflections (FFC) FILM: Recycling in Action (FFC)
8. Reducing Solid Wastes (3.5 h) *product reuse; reduction of excess packaging; increased product lifetime; decreased consumption.*	ACTIVITY: Discussion of life-style changes that will result in a reduction in solid wastes. FILMSTRIP: The Beer Can by the Highway (PH)
9. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT C.4 ENERGY AND AGRICULTURE Canadian farmers need a continuing supply of energy in order that our country can achieve and maintain a level of food production that will make Canada self-sufficient in food commodities normally produced in temperate regions and, at the same time, permit Canada to assist other countries with the feeding of their growing populations. This unit is designed to make students aware of the need to give agriculture a priority position should energy allocation be necessary in the future. This objective is accomplished through a consideration of efficiency in agricultural production, energy sources and energy utilization.	
1. Importance of Energy in Agriculture (2.5 h) *dependency on fossil fuels for mechanization, fertilizers, crop drying, pesticides and transportation; need for Canadian (and Ontario's) agriculture in the world community; percent of national energy consumption used in agriculture; associated energy uses (processing and packaging, transportation, household preparation).*	FILM: Agriculture Canada (NFB) ACTIVITY: Study of data and graphs on energy utilization in agriculture. Refer to Energy in Society, Resource Guide, 1978, Ministry of Education
2. Present Efficiency in Agricultural Production (1.5 h) *efficiency in crop production; efficiency in animal production; comparison with former non-mechanized farming methods.*	FILM: Waterloo Farmers (NFB)
3. Energy Sources and Potential Use on Farms (3.0) *petroleum; coal; gases; solar; wind; energy conservation.*	FILM: The Search for New Energy: Parts I and II (CFI) FILMSTRIP: Renewable Energy Resources: Wind, Water and Solar Rays (S & M)
4. Increasing Efficiency of Food Production, Distribution and Use (4.0 h) *increasing efficiency of crop production; increasing efficiency in animal production; increasing efficiency in food processing and packaging; increasing efficiency in food distribution; increasing efficiency in household preparation.*	ACTIVITY: Study of data in "Energy and Agriculture in Ontario" (Ontario Institute of Agrologists)
5. Indirect Ways to Increase Energy Efficiency (1.0 h) *preservation of Class 1, 2 and 3 land; proper utilization of farm "wastes".*	ACTIVITY: Establishing a priority system for energy allocation in Canada.
6. Review and Evaluation (2.0 h)	ACTIVITY: Study of "Energy and Agriculture" (Ontario Ministries of Energy and Agriculture and Food)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT C.5 ENVIRONMENTAL LAW This unit is designed to give senior students an insight into their environmental rights and to explain how all citizens can assert those rights legally and politically. The book *Environment on Trial* (Canadian Environmental Law Association) would be a useful student resource for use during the teaching of this unit.	
1. Introduction to Environmental Law (1.5 h) *need for environmental laws; need for citizen involvement; history of environmental Law in Ontario; the Canadian Environmental Law Association.*	ACTIVITY: Visit from an environmental lawyer, urban planner or appropriate government official.
2. Administration of the Environment (1.5 h) *federal jurisdiction (e.g. Canada Water Act, Clean Air Act, Fisheries Act, Criminal Code); provincial jurisdiction (e.g. Provincial Parks Act, Pits and Quarries Control Act, Environmental Protection Act, Public Health Act, Environmental Assessment Act); municipal jurisdiction (e.g. municipal noise by-laws, the Planning Act, the Municipal Act).*	ACTIVITY: Investigation of a selection of federal, provincial and municipal environmental laws. ACTIVITY: Visit to a courthouse, preferably while an environmental case is before the court.
3. Problem Areas (4.0 h) *a discussion of laws and their administration for air pollution, noise pollution, water pollution, pits and quarries, waste management, litter, pesticides and radiation.*	ACTIVITY: Preparation of a paper treating one of the problem areas in detail.
4. Provincial Parks (2.0 h) *Provincial Parks Act; Wilderness Areas Act; park classification system; commercial exploitation of parks; management and policing of parks; current problems.*	ACTIVITY: Study of master plans for selected provincial parks.
5. Land Use Planning (1.0 h) *controlling land use; decision-making bodies; defending your rights.*	
6. Strategy for Action (4.0 h) *damages and injunctions; common law rights; using the law; costs and procedures; when and how to use a lawyer; waging a campaign.*	ACTIVITY; Conducting a mock trial on an environmental matter. ACTIVITY: Involvement of the class in an environmental issue.
7. Review and Evaluation (2.0 h)	

UNIT C.6 HUMAN POPULATION ECOLOGY

The global population is increasing exponentially. Many countries are experiencing economic, social and political problems as well as starvation, chronic malnutrition and disease. This unit provides students with an understanding of human population growth and its attendant problems. It also investigates possible solutions to the population problem. This unit is best taught to senior students who already have some knowledge of basic ecological principles.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Population Ecology (2.5 h) *population; population size; population density; biotic potential; environmental resistance; population growth; population growth curve; sigmoid curve; natality and mortality rates; carrying capacity; factors affecting population density; exponential growth; doubling time.*	ACTIVITY: Plotting of population growth curves from data for algae, invertebrates and vertebrates. FILM: Population Ecology (EBE)
2. Growth of the World's Population (1.0 h) *history of the growth; the growth curve; present population; present doubling time; projections for the future.*	ACTIVITY: Plotting the human population growth curve from data.
3. Carrying Capacity of the World (1.5 h) *factors determining carrying capacity; distribution of wealth; resources and people on the earth; standard of living and carrying capapcity.*	FILMSTRIP: World Resources and Responsibilities (PH) ACTIVITY: Debate on what constitutes an acceptable standard of living for a Canadian.
4. Feeding the World's People (3.0 h) *available land; water; plant and animal breeding; domestication of new species of plants and animals; diseases of plants and animals; crop protection; food from the sea; fish farming; aquaculture; eating lower on the food chain; "synthetic" foods; modernization of agriculture (mechanization, fertilization and pesticide use); climate and weather; cultural and hygiene problems with food distribution and use.*	FILM: Operation Sahel (UN) FILMSTRIP: Food, Will There Be Enough? (PH) FILM: Voices of Hunger (TL) FILM: Food (NFB) SOUND-SLIDE: Critical Issues in Science and Society; A World to Feed (S&M)
5. Causes for Population Increase (2.0 h) *population equation; birth and death rates for selected countries; decreasing death rate as a factor; factors causing death; how these factors have been lessened in modern society; other mortality factors (war, accidents, natural disasters, cancer, heart attacks, etc.); longevity.*	FILMSTRIP: Population (PH)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
6. Predicting Future Trends in Population (1.5 h) *population structure; survival rate (survivorship); fertility; making predictions for Canada and the world; outlook for the future.*	
7. Factors Influencing Fertility Rates (2.5 h) *tradition; economic motivation; self-satisfaction; education; availability of contraceptives.*	ACTIVITY: Visit from a member of Right to Life, Birth right, Planned Parenthood, Zero Population Growth or another population control organization.
8. Review and Evaluation (2.0 h)	SOUND-SLIDE: The Science and Ethics of Population Control: An Overburdened Earth? (S&M)

UNIT C.7 INDOOR GARDENING

The central purpose of this unit is to provide students with the knowledge and skills required to culture house plants successfully. For many students this unit could lead to a lifetime hobby.

1. Basic Plant Needs (1.0 h) *temperature; light; oxygen; carbon dioxide; water; minerals; humidity.*	
2. Basic Equipment (0.5 h) *lighting; pots; watering equipment; thermometers; misting apparatus; water and salts meters.*	
3. Soil (2.0 h) *sterilization; nutrient tests; pH test; soil mixes; artificial media.*	ACTIVITY: Sterilization of soil. ACTIVITY: Preparation of soil mixes. ACTIVITY: Testing the pH and nutrient levels of soil.
4. Growing Plants from Seed (1.5 h) *seed preparation such as scarification; sowing of seeds; conditions for germination; care of seedlings; damping off; thinning.*	ACTIVITY: Sowing of seeds and care of seedlings. FILM: How Seeds Sprout (IFB) ACTIVITY: Investigation of the effects of depth, soil moisture, temperature, and other variables on seed germination.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Other Methods for Growing Plants (1.5 h) *planting techniques for bulbs and corms; stem cuttings; leaf cuttings; air layering.*	ACTIVITY: Growing plants from bulbs, corms and cuttings.
6. Light Conditions (0.5 h) *deep shade plants; shade plants; diffuse light plants; partial direct light plants; direct light plants; window versus artificial light.*	ACTIVITY: Maintenance of a selection of plants in the classroom and at home.
7. Temperature Conditions (0.5 h) *optimum temperature; maximum and minimum temperatures; effects of sudden changes.*	
8. Water (1.0 h) *correct house plant watering; drench and dry plants; evenly moist plants; constantly wet plants; use of water meters; drainage; controlling excess salts with leaching; humidity control.*	ACTIVITY: Investigation of the effects of over- and under-watering of plants.
9. Feeding (1.0 h) *composition of fertilizers (N, P, K); liquid concentrate, slow release, natural organic and water soluble fertilizers; importance of pH; effects of over-fertilization and nutrient deficiencies.*	
10. Further Plant Care (0.5 h) *pinching back; pruning; vacation care.*	FILM: Bonsai - The Art of Training Dwarfed Potted Trees (MAC)
11. Recognizing Signs of Trouble (1.0 h) *causes of wilting, yellow leaves, sudden leaf drop, gradual leaf drop, pale green leaves, bud drop, curled leaves, brown leaf tips, root and stem rot, spindly growth and sticky leaves.*	
12. Pest and Disease Control (1.0 h) *symptoms and control of common pests and diseases of house plants.*	
13. Selecting Plants to Enhance a Room (1.0 h) *consideration of environmental conditions, space, growth characteristics of plants, compatible groupings.*	ACTIVITY: Visit to a greenhouse to examine the variety of potted plants.
14. Hydroponics (2.0 h) *materials, basic principles; advantages; commercial hydroponics.*	ACTIVITY: Growing of plants by means of hydroponics.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
15. Review and Evaluation (2.0 h)	

UNIT C.8 LIFE CYCLES

A knowledge of life cycles facilitates the study of such topics as plant propagation, plant and animal breeding and pest control. If your students did not study this unit in Intermediate Science, you may wish to include it in your Environmental Science course.

Time will not permit you to do all the topics in this unit. Select those most appropriate to the needs and interest of your students. Stress throughout the concept of life cycle and the meanings of sexual and asexual reproduction.

1. Asexual and Sexual Reproduction (1.0 h) *meanings of asexual and sexual; binary fission; budding; gametes; male gamete (sperm); female gamete (egg); zygote; fertilization.*	
2. Reproduction of Monerans (1.5 h) *asexual reproduction of blue-green algae by fission and by fragmentation; fission by bacteria.*	FILM: Bacteria (EBE)
3. Reproduction of Protists (2.0 h) *fission of amoeba or paramecium; conjugation of paramecia; fission of diatoms.*	ACTIVITY: Examination of slides showing fission and conjugation.
4. Life Cycles of Fungi (3.5 h) *life cycles of mushroom and a parasitic basidiomycete such as wheat rust or corn smut; life cycles of bread mould, yeast and apple scab.*	ACTIVITY: Examination of fungal spores. ACTIVITY: Examination of parasitic fungi. FILM: Wheat Rust (EBE) ACTIVITY: Culturing bread mould. ACTIVITY: Culturing yeast.
5. Life Cycles of Plants (4.0 h) *the generalized life cycle of most plants; the concepts of gametophyte, sporophyte and alternation of generations; conjugation of spirogyra; life cycle of ferns;*	FILMSTRIP: Sexual Reproduction of a Flowering Plant (PH) - 7 parts. FILM: Flowers at Work (EBE)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
life cycle of pine; life cycle of a flowering plant.	FILM: Gymnosperms (EBE) ACTIVITY: Examination of fern sporophyte and prothallus. ACTIVITY: Examination of conjugating spirogyra. ACTIVITY: Study of the reproductive parts of a representative flowering plant. FILM: The Plant Cell and Male and Female Flower Parts (SP)
6. Life Cycles of Animals (5.0 h) *life cycle of an earthworm; life cycles of insects (direct and indirect metamorphosis); life cycle of a frog; life cycles of mammals (including humans).*	FILM: Life Cycle of the Honeybee (NG) ACTIVITY: Following the life cycle of an insect such as a mosquito. FILMSTRIP: Life Cycles (NG) - 5 parts (mammals, fishes, birds, amphibians and reptiles, insects. FILMSTRIP: Male and Female Reproductive Systems (PH) - 4 parts. FILM: Life Cycle of Insects: The Incomplete Metamorphosis (IFB) FILM: Life Cycle of Insects: The Complete Metamorphosis (IFB)
7. Review and Evaluation (2.0 h)	

UNIT C.9 MINERAL RESOURCES AND MINING

Mining and mineral processing make up one of Canada's most important industries. The mineral resource industry contributes significantly to our way of life and to Canada's balance of payments in the world community. Yet conflicts often arise between factions of this industry and environmentalists. This unit is designed to give students sufficient understanding of this industry that they can participate as informed citizens in the resolution of such conflicts.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
Check with the science and geography departments before beginning this unit. Unnecessary duplication must be avoided. Emphasize topics of local significance.	
1. Canada's Mineral Resources (2.0 h) *identification of the locations of major mineral deposits such as iron, nickel, lead, copper, uranium, asbestos, aggregate, coal and petroleum; economic importance; estimates of resource size and lifespan.*	FILMSTRIP: Mining in Canada (PH) ACTIVITY: Examination of maps of mineral resources.
2. Exploration for Mineral Deposits (2.5 h) *economic and political issues; mineral rights; early prospecting methods; modern geophysical and geochemical methods (outcrop mapping, geochemical analysis of vegetation, seismic mapping, core sampling); frontier exploration; environmental problems.*	ACTIVITY: Study of regulations controlling mineral rights, prospecting, staking and mining. FILM: Offshore (NFB) FILM: Northlands Environmental Impact Study (CFI)
3. Mining Mineral Resources (2.5 h) *staking a claim; drilling; determination of ore body characteristics; extraction methods (surface mining, placer, open-pit, shaft); environmental problems.*	FILM: Miner (NFB) FILM: Portrait of a Coal Miner (NG) ACTIVITY: Staking a claim.
4. Processing Mineral Resources (2.5 h) *the process of milling (size reduction and concentration of minerals); specific techniques such as magnetic separation and froth flotation; environmental problems.*	ACTIVITY: Visit to a milling and/or extracting operation ACTIVITY: Concentration of minerals by froth flotation.
5. Extracting Metals from the Concentrate (4.0 h) *smelting, converting and refining; specific techniques for one or two common metals such as copper, iron and nickel; sulfur dioxide production and acid precipitation; reducing acid precipitation (economic, social and environmental factors).*	ACTIVITY: Concentration of minerals by magnetic separation. FILM: The Lead Matrix (NFB) ACTIVITY: Debate on the relationship among lifestyle, mineral resource depletion and environmental problems.
6. Review and Evaluation (2.0 h)	

UNIT C.10 NATURAL GARDENING AND FARMING

This unit provides students with the knowledge and skills they require to garden or farm without the use of pesticides and commercial fertilizers.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. Changing Agricultural Methods (1.5 h) *brief history; main changes (small family farms to large corporate operations, labour intensive to mechanization, diversification to specialization); advent and impact of chemical fertilizers; advent and impact of pesticides.*	FILM: Waterloo Farmers (NFB) FILM: Following the Plough (NFB)
2. Basic Principles (2.0 h) *reason for use of "natural" instead of "organic"; use of natural fertilizers; natural weed and insect control.*	ACTIVITY: Collection of information on specific matters such as biological weed control or the maintenance of soil fertility using sources such as *Organic Gardening*, *Harrowsmith* and *Countryside*.
3. The Natural Garden (5.0 h) *composting (reactants, conditions, products); building a compost heap; effects of compost on garden soil; weed control by cultivation; weed control and moisture conservation by mulching; crop rotation; compatible crops.*	FILM: Tara's Mulch Garden (NFB) ACTIVITY: Building and maintaining a compost heap. ACTIVITY: Planting and maintaining a natural garden.
4. The Natural Farm (4.0 h) *balancing crop and animal production; proper care and handling of manure; use of "green manure"; crop rotation; supplementing soil nutrients with natural products; soil management practices; animal husbandry practices.*	FILM: A Sense of Humus (NFB) ACTIVITY: Visit to a natural farm. FILM: The New Alchemists (NFB)
5. Review and Evaluation (2.0 h)	

UNIT C.11 NOISE POLLUTION

Noise pollution is an insidious form of pollution that ranges in the degree of harm it can do from annoyance and aggravation to psychological and physiological damage. Noise has long been a problem of urban areas. However, increased mechanization has

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
made noise a rural problem as well. This unit provides students with the knowledge they need to participate actively in noise abatement programs.	
1. Meaning of Noise (2.0 h) *sources of sound; characteristics of sound (intensity, frequency, quality); definition of noise.*	FILM: Noise Pollution (LCA) FILM: One Hand Clapping (NFB)
2. Decibel Scale (2.0 h) *definition of decibel; the decibel (dB) scale; the decibel-A (dBA) scale; sound intensities of a variety of sources.*	ACTIVITY: Measurement of sound intensities of several sources with a sound meter.
3. Noise in the Community (3.0 h) *students prepare, administer and analyze a questionnaire on the main sources and effects of noise in their community.*	ACTIVITY: Conduct an attitude-behaviour study on noise pollution in the community.
4. Effects of Noise (1.5 h) *interference with communication; physiological damage; duration and time of maximum acceptable exposures; pain threshold; hearing loss; psychological damage; intensities that cause tension, anxiety and hypertension; effects of noise on land use activities.*	FILM: Noise and Its Effects on Health (FFC) ACTIVITY: Investigation of the effects of loud noises on blood pressure. ACTIVITY: Conduct a transect study to compare noise levels with land use activities. ACTIVITY: Comparison of noise levels at several sites.
5. Noise Pollution and the Law (2.5 h) *federal jurisdiction; provincial jurisdiction; municipal jurisdiction.*	ACTIVITY: Study of federal, provincial and municipal laws relating to noise pollution.
6. Ways to Decrease Noise (1.5 h) *lessening the personal contribution; using the laws.*	
7. Review and Evaluation (2.0 h)	

UNIT C.12 . ONTARIO'S NORTHERN ENVIRONMENT

Few Ontarians live north of the 50th parallel. Yet that section of Ontario comprises more than half the province's land mass. Further, it contributes significantly to the economy through forestry, mining, energy production and tourism. Unfortunately, business interests from the south have often undertaken operations in the north with little thought being given to the effects on the natural environment and on the economic, social and cultural conditions influencing the lives of the people.

This unit gives students an opportunity to investigate the human and environmental consequences of economic change and resource use north of 50. Students should have access to *Issues Report, Royal Commission on the Northern Environment.* The teacher should conslut the Curriculum Guideline *People of Native Ancestry, 1981.*

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
1. The Land and People North of 50 (1.5 h) *boundaries of the area; geological, climatic, and biological characteristics; history; impact of Europeans on native people; present people and their communities; remoteness.*	ACTIVITY: Study of maps showing the geology and biology.
2. Industry and Commerce (2.5 h) *the present northern economy; development philosophies; forestry prospects and problems; mining prospects and problems; tourism.*	ACTIVITY: Study of maps showing mining and forestry potential.
3. Economic Realities (2.5 h) *need for effective planning; traditional pursuits; agricultural potential; wild rice as an aid toward self-sufficiency; land use conflicts.*	ACTIVITY: Debate on the rights of native people versus the good of the province as a whole.
4. Energy Production (1.5 h) *the north as a provider of coal, timber, uranium and hydro power; effects of projects on native people; resource use conflicts.*	ACTIVITY: Study of MNR documents such as the West Patricia Land Use Plan.
5. Impacts of Development (2.0 h) *need for negotiations on developments; cultural concerns; environmental concerns; economic impact; social effects.*	
6. Northern Shortcomings (2.0 h) *study of what remains to be done concerning education, health care, housing, recreation, transportation, communications and justice.*	ACTIVITY: Study and discussion of appropriate sections of the *Issues Report.*
7. Review and Evaluation (2.0 h)	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
UNIT C.13 PLANT DISEASES AND PESTS This unit deals with the life cycles, biological effects, economic importance and control measures for some representative diseases and pests that affect major agricultural crops in Ontario. You may wish to teach this unit in conjunction with Unit 12.1, Pesticides in the Environment.	
1. Rusts (2.0 h) *common host plants; effects on host; life cycle of wheat rust; control with fungicides; control through rust resistant strains; economic importance.*	ACTIVITY: Study of life cycle of wheat rust. FILM: Wheat Rust (NFB)
2. Smuts (2.0 h) *common host plants; effects on host; life cycle of corn smut; control with fungicides; control through smut resistant strains; control through fall ploughing; economic importance.*	FILMSTRIP: Corn Production - Insects and Diseases (BPI) ACTIVITY: Study of the life cycle of corn smut.
3. Root Rot (1.5 h) *causes and effects of root rot of wheat, barley and soybeans; chemical control; control through crop rotation; economic importance.*	FILMSTRIP: Soybean Production - Protection from Weeds, Diseases and Insects (BPI)
4. Powdery Mildews (1.5 h) *effects on wheat, barley, corn and other grains, beans, grapes and apples; life cycle; control with fungicides; effect of weather on severity; economic importance.*	
5. Corn Root Worm (2.0 h) *effects on corn; life cycle; chemical control; control through crop rotation; economic importance.*	FILM: The World of Insects (NG) FILM: Insects Harmful to Man (IFB)
6. Alfalfa Weevil (1.5 h) *effects on alfalfa; life cycle; chemical control; control through crop rotation; economic importance.*	ACTIVITY: Identification of common pests such as corn root worm, alfalfa weevil, corn borer and potato beetle.
7. Parasitic Nematodes (1.0 h) *biological action; susceptible crops; chemical control; economic importance.*	FILM: Nematodes (NFB) ACTIVITY: Microscopic examination of nematodes.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
8. Apple Scab (1.5 h) *effects on apples; life cycle; control with fungicides; control through orchard husbandry; economic importance.*	ACTIVITY: Examination of apple scab with a hand lens and study of the life cycle.
9. Fruit and Vegetable Pests (1.5 h) *general discussion of insects, mites and other pests that attack apples, potatoes or some other local crop; control with pesticides; control through IPM (integrated pest management); control with pheromones.*	ACTIVITY: Visit from the agricultural representative to discuss IPM. FILMSTRIP: Pest Management: An Integrated Approach (VEP) - 5 parts
10. Review and Evaluation (2.0 h)	

UNIT C.14 ROCKS AND MINERALS

If this unit was not taught to your students in Intermediate Science, you may wish to teach it before you do Unit C.8, Mineral Resources and Mining, or before you teach any unit on soils. Student collections of rocks and minerals should form an integral part of this unit.

1. Differences Between Rocks and Minerals (0.5 h) *general characteristics of rocks and minerals.*	ACTIVITY: Classification of materials as rocks or minerals.
2. Classification of Rocks (2.0 h) *characteristics and formation of igneous, metamorphic and sedimentary rocks; the rock cycle.*	ACTIVITY: Classification of rock samples. FILM: Rocks That Form on the Earth's Surface (EBE) FILM: Rocks That Originate Underground (EBE)
3. Rock Formations (1.5 h) *how major igneous, metamorphic and sedimentary rock formations are created; local rock formations; rock profiles.*	FILM: Minerals and Rocks (EBE)
4. Weathering of Rocks (1.0 h) *physical weathering; erosion; chemical weathering.*	FILM: Erosion - Leveling the Land (EBE) ACTIVITY: Examination of sand with a hand lens and microscope. FILM: Face of the Earth (EBE)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
5. Identification Tests for Minerals (2.5 h) *use of physical properties such as hardness, streak, fracture and cleavage, colour and transparency, crystal form, smell and feel; Moh's Hardness Scale.*	ACTIVITY: Growing crystals from a solution of salt, sugar, alum or copper sulfate.
6. Classes of Minerals (2.5 h) *metallic minerals containing metals such as copper, nickel, iron and lead; non-metallic minerals such as graphite, mica, sulfur and talc; gem minerals such as amethyst, zircon, and emerald.*	ACTIVITY: Examination of samples of the three classes of minerals.
7. Fossil-Bearing Rocks (2.0 h) *formation of fossils; importance of the study of fossils; main categories of fossils.*	ACTIVITY: Examination of fossil-bearing rocks.
8. Review and Evaluation (2.0 h)	

UNIT C.15 SOIL ECOLOGY

A soil ecosystem provides an interesting, challenging and accessible environment in which to learn ecological principles. Field trips are as close as the door of the school, and the same ecological principles operate in the soil of the schoolyard as operate in a forest, stream or lake.

1. The Biotic Component of a Soil Ecosystem (4.5 h) *examples and definitions of producers, consumers, decomposers, herbivores, carnivores, parasites, saprophytes and scavengers; habitats, niches and trophic levels of earthworms, enchytraeids, nematodes, snails, slugs, millipedes, centipedes, sow bugs; mites, springtails, ants, termites and soil beetles; soil mircoorganisms such as protozoa, fungi, bacteria and actinomycetes; examples of food chains and webs.*	FILM: The World at Your Feet (NFB) ACTIVITY: Extraction of arthropods from soil using a Tullgren funnel. ACTIVITY: Extraction of nematodes from soil using a Baermann funnel.
2. The Abiotic Component of a Soil Ecosystem (4.0 h) *inorganic component of soil; organic component of soil; gaseous component of soil; particle size; pore space; pH; nutrients; temperature; water content.*	ACTIVITY: Determination of water content of soil. ACTIVITY: Determination of organic content of soil.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
	ACTIVITY: Determination of soil pH and nutrient concentrations.
3. Interdependence of Biotic and Abiotic Components (2.0 h) *examples of relationships between soil conditions and species of organisms.*	ACTIVITY: Study of responses of earthworms to soil conditions. ACTIVITY: Study of the role of sow bugs in the composting of leaves and other vegetation.
4. Nutrient Cycles (2.0 h) *water, carbon, nitrogen and phosphorus cycles.*	
5. Energy Flow (1.5 h) *soil autotrophs; soil heterotrophs; aerobic and anaerobic respiration in soil; energy flow along two or three representative food chains.*	
6. Review and Evaluation (2.0 h)	

UNIT C.16 SOIL SCIENCE

This unit is designed primarily for students in agricultural areas. Its main objective is to encourage proper soil management through an understanding of the properties of soil. Your students should have access to *Ontario Soils* (Publication 492, Ministry of Agriculture and Food) during the teaching of this unit.

1. What is a Soil? (1.5 h) *main components; soil formation; profile development; soil classification.*	FILMSTRIP: Soil and the Agricultural Environment (VEP)
2. Classes of Agricultural Land (1.0 h) *the seven land use capability classes; factors used to classify agricultural land; characteristics of each class; area of Ontario in each class.*	ACTIVITY: Classification of local agricultural lands.
3. Physical Properties of Soil (4.0 h) *texture; structure; porosity, aeration; soil moisture (field capacity, permanent wilting point, capillarity, percolation rate, available moisture, gravitational water, hygroscopic moisture); thermal properties.*	ACTIVITY: Determination of soil texture. ACTIVITY: Determination of soil water content. ACTIVITY: Determination of soil water holding capacity.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
	ACTIVITY: Determination of percolation rate. ACTIVITY: Determination of soil particle size.
4. Chemical Properties of Soil (2.5 h) *mineral component; organic component; soil colloids; pH; nutrients.*	ACTIVITY: Determination of organic content. ACTIVITY: Determination of soil pH and nutrient concentrations.
5. Biological Properties of Soil (1.0 h) *a brief survey of microorganisms (bacteria, actinomycetes, fungi, algae) and invertebrates.*	FILM: The World at Your Feet (NFB)
6. Plant Nutrients (2.0 h) *sources and functions of macro- and micronutrients; nutrient cycles; leaching; importance of microorganisms.*	ACTIVITY: Effects of nutrient deficiencies on plant growth.
7. Soil Management (3.0 h) *fertilizer choice and use; maintaining the proper pH; soil tilth and tillage; land drainage; causes and prevention of soil erosion; use of manures.*	FILMSTRIP: Soil: Its Meaning for Man (PH) FILM: Erosion - Leveling the Land (EBE)
8. Review and Evaluation (2.0 h)	

UNIT C.17 THE ATMOSPHERE, WEATHER AND CLIMATE

If you find that your students lack adequate knowledge of the nature of the atmosphere, climate and weather, you may wish to teach this unit prior to dependent units such as Air Quality, Terrestrial Ecosystems, Horticulture and Agricultural Crop Science.

1. Structure of the Atmosphere (1.0 h) *layers (troposphere, stratosphere, mesosphere, thermosphere, ionosphere, exosphere); ozone layer.*	
2. Composition and Importance of Air (2.0 h) *composition by volume of air; importance of major gases; greenhouse effect.*	ACTIVITY: Finding the percent by volume of nitrogen and oxygen in air.
3. Meaning of Weather (5.5 h) *definition; weather factors (wind, cloud, visibility, temperature, humidity, precipitation); Beaufort scale; classification of clouds; impact of air masses on weather; types of precipitation; dew point; weather forecasting; making weather charts; the wind chill factor.*	ACTIVITY: Estimating wind speeds using the Beaufort scale. FILM: The Origins of Weather (NFB) ACTIVITY: Keeping a daily journal of cloud types. ACTIVITY: Determination of the dew point. ACTIVITY: Making a weather chart and forecasting the weather. FILMSTRIP: Forecasting the Weather (NG) SOUND-SLIDE: Understanding Weather and Climate (S & M) FILM: Above the Horizon (NFB)

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
4. Meaning of Climate (2.0 h) *definitiön; macro- and microclimate; classification of macroclimates (continental, marine, mountain, temperate, tropical, polar); climatic cycles; climate alteration.*	FILM: In All Seasons (NFB)
5. Climate and Biomes (2.5 h) *definition of biome; major biomes; how climate determines the structure of biomes; climatograms.*	FILM: The Climates of North America (NFB) ACTIVITY: Plotting of climatograms from data and using climatograms.
6. Review and Evaluation (2.0)	

UNIT C.18 URBAN FORESTRY

This unit is designed to give students an appreciation of the importance of trees in urban environments and to impress upon them the need for the continual planting and maintenance of trees in our towns and cities.

1. Identification of Native Trees (3.0 h) *nomenclature and classification of trees; identification of major coniferous and deciduous native trees; use of dichotomous keys; use of winter twigs for identification.*	ACTIVITY: Identification of conifers from twig and cone specimens. ACTIVITY: Identification of deciduous trees using leaves. ACTIVITY: Identification of deciduous trees using winter twigs.
2. Identification of Exotic Trees (2.5 h) *creation of atypical climates by cities (e.g. Carolinian); identification of locally common exotics using nursery catalogues; evaluation of the use of exotic species instead of native species.*	FILM: Urban Impact on Weather and Climate (LCA) ACTIVITY: Walking tour of the area to identify native and exotic trees. FILM: Trees and How to Know Them (IFB)
3. Functions of Trees in Urban Areas (1.0 h) *aesthetics; pollution abatement; oxygen production; wind control; shade; temperature control; privacy.*	

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
4. Planting and Maintenance of Trees (4.5 h) *tree nurseries; silvicultural characteristics of common species; choice and placement of species based on aesthetics, size, shape, desired functions, consideration of the future and environmental requirements; planting techniques; fertilizing; watering; pruning; wound repairs.*	FILM: Trees and Their Care (IFB) ACTIVITY: Preparation of a plan to revitalize a section of the town or city by planting and maintaining trees.
5. Common Pests and Diseases (2.0 h) *history of a disease or pest with a major impact (e.g. Dutch elm disease); importance of species diversity and species selection in pest and disease control; control of three or four locally important diseases or pests with pesticides.*	ACTIVITY: Identification of common insect pests and the damage they do. ACTIVITY: Participation in an "Arbor Day" event.
6. Review and Evaluation (2.0 h)	

UNIT C.19 WILDLIFE BIOLOGY

This unit is designed to acquaint students with the needs and behaviour of major species of wildlife in Canada and to make the students aware of the factors, positive and negative, that impinge upon the well-being of wildlife populations. The objectives and principles of wildlife management are an important part of this unit.

1. Values of Wildlife (1.0 h) *ecological importance of selected species; importance of species diversity to ecosystem stability; maintenance of future genetic options; importance to humans (aesthetics, commercial, recreation, scientific).*	
2. Canadian Wildlife (1.0 h) *identification of game and non-game species; commercial and non-commercial species; migratory birds; fur-bearers.*	
3. Habitat (1.5 h) *identification of the habitats of selected species; threatened habitats; factors affecting habitats; efforts to improve habitats.*	FILM: Waterfowl - A Resource in Danger (NFB) ACTIVITY: Field trip to a local conservation area to identify examples of poor and good habitat management.

CONTENT SUMMARY	ACTIVITIES AND RESOURCES
4. Food and Feeding (1.5 h) *identification of feeding habits, trophic levels and food chains and webs for selected species.*	
5. Behaviour (2.5 h) *a study, for selected species, of: inter- and intraspecific competition; learned behaviour; instincts; biological clocks and their roles in reproduction, migration, hibernation and colour changes; movement (territoriality, colonization, habitat selection, social stress, migration).*	ACTIVITY: Research the behaviour of a locally important species.
6. Population Ecology (2.0 h) *population size and density; biotic potential; environmental resistance; population growth curves; natality and mortality rates; carrying capacity; factors affecting population density; limiting factors.*	FILM: Population Ecology (EBE) ACTIVITY: Plotting population growth curves from data on major species.
7. Wildlife Management (2.5 h) *objectives; basic principles (habitat improvement, population control through hunting, predator control, food supply control); open and restricted hunting seasons; regulations; impact of sport hunting; management of selected game species and fur-bearers; management of non-game species.*	FILM: Ecology: Managing Wildlife Resources (CFI) FILM: A Great White Bird (NFB) FILM: Keepers of Wildlife (NFB) FILMSTRIP: Managing Wildlife: Is It For You? (VEP)
8. Endangered Species (2.0 h) *Ontario and Canada's endangered species list; factors creating endangered species; protecting endangered species.*	FILM: Say Goodbye (VEC) FILM: Memories from Eden (TL) FILM: The Empty Nest (LCA)
9. Government Agencies (1.0 h) *roles of the Canadian Wildlife Service, Ministry of Natural Resources and the local Conservation Authority.*	FILM: Atonement (NFB) FILM: Death of a Legend (NFB)
10. Review and Evaluation (2.0 h)	ACTIVITY: Debate on the ethics of wildlife management to satisfy human wants such as sport hunting.
UNIT C.20 LOCALLY DESIGNED UNIT	

PART C: APPENDICES

APPENDIX A: SAFETY IN THE LABORATORY AND FIELD

LABORATORY SAFETY

Introduction

In all environmental science courses, teachers should strive to instill in their students a positive attitude towards safety. An awareness of safety should be developed through a common-sense approach. Scare techniques must be avoided.

When conducting experiments, students should be expected to follow directions as given, to understand the importance of what they are doing, to maintain order and neatness in arranging their equipment, to use prior knowledge in making judgements, and to ask for advice when in doubt.

Students must be impressed with the importance of following instructions exactly. Of course, the teacher must give complete and exact directions and insist that they are obeyed fully. It cannot be assumed that all students know of the corrosive power of acids and bases, of the poisonous effects of mercury or asbestos, of the danger of carbon tetrachloride fumes, of the explosive nature of certain gases, or of the hazards of handling some micro-organisms.

Scientific knowledge plays a vital role in laboratory safety. Students should often learn by experimenting, but such experimentation must be judiciously directed. No laboratory work should be expected of the students where they may not be fully aware of possible hazards and their prevention.

Teacher Responsibility

The most effective method of teaching safety is by example. The techniques, procedures, and attitudes displayed by the teacher are likely to influence students more than actually teaching them a unit on safety. The teacher should be conscious of the example he or she exhibits towards safety and should encourage the development of the following traits or attitudes:

- careful observation and alertness at all times;
- constant application of safety techniques;
- constructive criticism of experimental procedures;
- recognition of the need for experimental design and the responsibilities associated with such design.

Teachers should practise effective surveillance of all students, with an emphasis on accident prevention. Students should be alerted to situations that they have created that could be unsafe or hazardous.

The following guidelines should be of assistance to teachers in avoiding and treating accidents and in manipulating apparatus:

- Teach and practise safety at all times.

- Practise the traits and attitudes expected of students.

- Never leave students in the laboratory unsupervised during a potentially dangerous experiment.
- Test all experiments before the students perform them.
- Caution students and alert them to potential hazards before they attempt an experiment.
- Do not permit any form of "horseplay" in the laboratory.
- Establish a routine of having students make a safety check of apparatus before using it in an experiment.
- Before using a chemical, use your knowledge of it to determine the safe storage, handling, and transporting procedures for it.
- Provide safety equipment for individual student use: for example, protective eyewear. Inspect it and keep it in good repair.
- Inspect storage areas frequently to eliminate potential hazards.
- Before performing experiments, have the laboratory or classroom equipped with the proper safety equipment, for example, complete first-aid kit, fire blanket, fire extinguishers, fire pail, and sand.
- Make sure students know how to use safety equipment.
- Be familiar with current first-aid treatment, such as that for the treatment of burns.
- Be familiar with the routine to follow in your school in case of an accident. Be aware of who else may be called upon for assistance with first aid in the school.
- On the first appropriate day, instruct students on what to do if chemicals get in their eyes.
- Frequently inspect laboratory and classroom facilities, such as gas fixtures, electric outlets and connections, fume hoods, and exhaust fans. Have them repaired if defective.
- Ensure that students are properly supervised when handling dangerous substances.
- Do not perform or have students perform any experiments that could produce a hazard for which you as the teacher could not provide first aid.
- Emphasize conducting experiments in logical, organized steps, avoiding unnecessary movement or crowding in the classroom.
- Do not use any new products or untried substitutes without having the benefit of testing to determine possible limitations or hazards.
- Encourage students to carry out safety procedures without making them afraid to experiment.
- Have available for immediate reference when needed information on safety and first aid.
- Stress the importance of special care when handling glass tubing. (See *Intermediate Division Science, 1978*, page 220.)

Student Responsibility

At the beginning of each year, students should be alerted to general safety precautions. To guarantee continuing safety, students should become familiar with the condition and safety features of all equipment and chemicals used. They should plan their laboratory exercises and experiments to minimize the possibility of accidents. They should record and investigate with the teacher any accidents or unexpected events that occur.

Students *should:*

- be familiar with the location and use of safety equipment in the classroom or laboratory;
- report all accidents to the teacher at once no matter how minor;
- wear safety equipment such as protective eyewear when required (if contact lenses are worn, they should be removed immediately if a foreign body or liquid enters the eye);
- report broken equipment, damaged or defective facilities, and suspicious-looking chemicals to the teacher;
- wash up after working with preserved specimens, micro-organisms, or poisonous materials;
- practise safety inside and outside of the classroom;
- maintain an uncluttered work area.

Students *should not:*

- wear loose clothing near flames or permit long hair to come near open flames (loose clothing and long hair must be tied back);
- conduct experiments without proper supervision;
- handle apparatus, chemicals, live animal specimens, or poisonous plants without specific previous instructions;
- transport dangerous materials at any time without full knowledge of and adherence to safety precautions;
- handle any material in the classroom, laboratory, or storage room without permission;
- taste chemicals or other materials without specific instructions and supervision by the teacher;
- remove glass tubing from, or insert it into, rubber stoppers without teacher supervision;
- leave a lighted burner unattended (burners should be extinguished or shut off when not being used).

SAFETY ON FIELD TRIPS

Preplanning, Organization and Supervision

Dangerous situations seldom arise on field trips that are properly preplanned, organized and supervised and for which the students have the necessary abilities and skills.

- *Preplanning:* Visit the site of the field trip well in advance of the outing. As you plan activities for the students, make careful notes regarding potential hazards. Alert students to these hazards during your classroom preparation and involve the students in the preparation of a list of safety rules. Make sure that the trip will be within the capabilities of the students.

- *Organization:* Organize the day's activities so that *all* students are involved in useful activities at *all* times. Students with well-defined tasks to do seldom engage in the horseplay that is responsible for many of the accidents that occur on field trips.

- *Supervision:* Make sure that *all* students are adequately supervised at *all* times. At no time should students be working in potentially hazardous situations without the direct supervision of an adult. In general, most teachers find the presence of two or three adults beneficial. Be sure to consult your board regulations for the board's required number of supervisors.

School Board Guidelines

Because of the wide diversity in the nature of field trips, specific safety rules cannot be listed here. Your school board has guidelines for the safe administration of field trips. These should be consulted and adhered to in the planning and supervision of all field trips.

SAFETY USING PLANTS

When flowers and bread mould are handled, care should be taken that pollen or spores are not excessively distributed throughout the classroom. Some students may be allergic to pollen or spores. As well, some plants in gardens, fields, forests, or at home may be poisonous, even though they are pretty. Poisonous plants may cause:

1. stomach and intestinal irritation;
2. poisoning of the system;
3. mouth and throat-lining irritation;
4. skin irritation.

The seriousness of plant poisoning will usually depend upon the amount swallowed. For some plants, even a small amount can be dangerous. The following are lists of common toxic plants. The number or numbers in parenthesis indicate the possible effects of swallowing them, as listed above.

House Plants:

caladium (1,3)
castor bean (1,2)
dieffenbachia (1,3)
elephant's ear (1,3)
lantana (2)
mistletoe (1,2)
philodendron (1,3)
poinsettia (4)
A number of other poisonous plants, which are not native to Canada, are also grown indoors.

Vegetable Garden:

potato - new shoots (2)
rhubarb - leaf blade (2)

Flower Garden Plants:

autumn crocus - meadow saffron (2)
Christmas rose (1,4)
daffodil (1)
foxglove - leaves and seeds (2)
golden chain (2)
hyacinth (1)
iris - blue flag (1)
larkspur - delphinium (2)
lily-of-the-valley (2)
monkshood (2)
morning glory (2)
narcissus (1)
snowdrop (1)
sweet pea - in large amounts (2)

Ornamental Plants:

daphne (1)
mountain laurel (2)
rhododendron (2)
wisteria (1)
yew (1)

Field Plants:

buttercup (1)
death camas (2)
false hellebore (2)
poison hemlock (2)
poison ivy (4)
pokeweed - inkberry (1,2)
snow-on-the-mountain (4)
thorn apply - jimson weed (2)

Trees and Shrubs:

black locust (1,2)
box (1,2)
cherry - twigs, leaves, and bark (2)
elderberry - black elder (2)
horse chestnut (1,2)
privet (1)

Marsh Plants:

cowslip - marsh marigold (1)
skunk cabbage (1,3)
water hemlock - cowbane (2)

Forest Plants:

baneberry (1,2)
bloodroot (1,2)
fly agaric mushroom (2)
deadly amanita - deadly (2)
jack-in-the-pulpit (1,3)
May apple (1)

moonseed (2)
poison ivy (4)
poison oak (4)

Students should observe the following points about poisonous plants:

- Learn about the plants in your area that could cause harm.
- Learn to recognize the most common poisonous plants, such as poison ivy.
- Do not eat wild plants, including mushrooms.
- Do not eat any unknown plant, nor suck plant nectar.
- Do not handle plants excessively or collect them.
- Do not brew home-made medicines from plants.
- Keep plant seeds, bulbs, and fruit well away from small children.

If a student chews on or swallows part of a plant that is suspected of being poisonous, induce the student to vomit. Seek medical help; even simple skin irritation may deserve medical attention. A sample of the suspected plant may aid in the determination of needed treatment. In general, it is wise to leave plants in their natural state alone.

APPENDIX B: ANIMAL CARE

Introduction

Teachers of environmental science have a responsibility to develop in their students a respect for life and an understanding of the conditions necessary for its perpetuation. To this end, living organisms should be available to be studied and cared for by students. Students should learn their responsibilities towards living organisms and should be involved in their care and maintenance. They should take pride in their ability to maintain animals and plants in a healthy state and in a proper environment for which they, the students, are responsible. Today's emphasis on the environment makes it imperative that students experience the environmental necessities for maintaining life. The principles of animal care related to such variables as nutrition, cleanliness, space, exercise, and temperature can be compared to the principles governing the maintenance of human life with dignity in a proper environment.

The Animals for Research Act and Ontario Schools

The Ontario Animals for Research Act is legislation that deals with animal care. When it was passed, it was the first comprehensive legislation providing for the comfort and well-being of all vertebrate animals in research. "Vertebrate" includes birds, fish, turtles, salamanders, and snakes, as well as such other common classroom residents as mice, rats, guinea pigs and rabbits.

"Research" is defined in the act as "the use of animals in connection with studies, investigation and teaching in any field of knowledge". This is a broad definition; hence, the Veterinary Services Branch, Ministry of Agriculture and Food, is concerned not only with the use of animals in university, industrial, diagnostic, and institutional laboratories, but also with the use of animals for teaching in elementary and secondary schools and with the experimental use of animals at science fairs. In the same way, the term "research facility" is a comprehensive one and every establishment, however small or large, that uses animals for studies, investigation, and teaching comes under the jurisdiction of the legislation.

Ontario schools have been exempt from registration as research facilities under the act, as well as from some of the regulations concerning room construction and procurement of animals; however, all other relevant portions of the act and its regulations apply to school and home animal projects.

The Animals for Research Act requires that every research facility or school that has or uses live animals during the school year come under the jurisdiction of an "animal care committee". The animal care committee is a peer committee. It may be made up of any number of persons. The qualifications of the animal care committee members are not specified, with the exception that one of its members must be a veterinarian. Animal care committees may be composed of teachers, consultants, supervisors, and persons outside the education system such as lawyers and animal care technicians.

A local animal care committee is appointed by one or more school boards. The animal care committee is responsible to the public through the Veterinary Services Branch; thus, a peer-government control system is being developed.

The initial task of the animal care committees will be to assemble to review and approve animal-project proposals in the schools and by the students under their jurisdiction. The animal care committee has the initial responsibility in the enforcement of the "pain clause" and may order that any project cease.

Animal care committees will control the character of animal utilization in schools in their area. It is expected that animal care committees will develop a standard list of animal projects which teachers in their area can use without further red tape. Any teacher or student who wishes to deviate from the standard procedures would be required to submit a separate project proposal for approval.

The "pain clause" requires that no animal suffer unnecessary pain. A project that may be necessary in a university of college teaching situation may be totally unacceptable and unnecessary at the pre-university level. The regulations do not clarify, grade, or specify a measure for pain. It is the task of the local animal care committee to determine what is suitable in their community, their schools, their grades, and with their students. It is recommended that in order to determine whether a project is suitable and necessary consideration be given to the following:

- the age, background, and intelligence of the student, and the capacity of the student to benefit from the experience;

- the total group of activities of which the animal project is a part;

- the preparation of the student and the follow-up lessons;

- the scientific design and the merits of the project;

- the merits of an alternative use of non-sentient material or lower forms of living material;

- the competence of the teacher or supervisor in relation to the proposed project;

- the level of competent supervision by teachers or qualified persons in the related field.

Ideally, these facts are best determined at the local level by teaching peers and the community through the local animal care committee.

In addition, the animal care committee has responsibilities concerning the activities and procedures related to the care of animals, the standards of care and facilities for animals, and the training and qualifications of persons who are engaged in the care of animals in schools. The acceptance of these responsibilities should produce a nucleus of trained personnel, resource material, and local expertise that will be available to teachers on animal projects, animal care itself, and animal care equipment.

The act and its regulations touch on all aspects of animal care and use. The regulations are general in nature and, in most cases, refer to the health, welfare, and comfort of the animal. The regulations discuss light, ventilation, temperature control, feed and water, cage requirements, cage cleaning and care. Euthanasia procedures are restricted. Amphibians, reptiles, non-human primates, and dogs and cats receive further attention in special sections in cases where their needs are not fully met by the general regulations.

The enforcement of the act and its regulations is through the animal care committee, spot inspection of schools, investigation of complaints, and inspection of science fairs by veterinarians and animal health technicians.

The Animals for Research Act controls the use of animals in science fairs in Ontario. Its application in regional science fairs has indicated that the peer-government system of control can achieve desirable results at the pre-university level.

The aim of the act is not, as some people have feared, the abolition of the use of animals in schools, but rather the proper maintenance and use of animals that are in the schools or involved with school-related projects. Both teachers and students must be conscious of the fact that today's students have moral and legal responsibilities for animals in their future studies or work; this early experience with proper animal care, proper animal use, and legislation is a necessary part of education. The Animals for Research Act and its regulations are available from:

The Director
Veterinary Services Branch
Ministry of Agriculture and Food
Parliament Buildings
Queen's Park
Toronto, (Ontario) M7A 1A3
(416) 965-5841

Although invertebrates are not specifically mentioned in the Animals for Research Act, they should be given the same care and consideration as vertebrates if you hope to develop in your students an environmental ethic that is based on a reverence for all forms of life.

Guiding Principles Governing the Use of Animals

These guiding principles have been prepared by the Canadian Council on Animal Care. They are recommended for use by departments of education and school boards across Canada so that adequate safeguards exist to ensure the proper care and use of animals in experimentation in the classroom in the schools in their jurisdiction. *These guidelines are not for use by students preparing projects for exhibit in science fairs.* Students preparing projects for science fairs must adhere to the Youth Science Fair Regulations for Animal Experimentation.

Biological experimentation involving animals in the classroom is essential for an understanding of living processes. Such studies should lead to a respect for all living things. All aspects of the study must be within the comprehension and capabilities of the students undertaking the study.

Lower orders of life are preferable subjects for experimentation at the pre-university level. Bacteria, fungi, protozoa, and insects can reveal basic biological information; they should be used for experimentation wherever and whenever possible.

All students conducting projects involving *vertebrate animals* should adhere to the following guidelines:

•No experimental procedures shall be attempted on a vertebrate animal that would subject it to pain or distinct discomfort, or interfere with its health.

•Anesthetic agents must not be used.

•Surgery on vertebrate animals shall not be performed.

•Experimental procedures shall not involve the use of:

1. micro-organisms that can cause diseases in humans or other animals;
2. ionizing radiation;
3. cancer-producing agents;
4. chemicals at toxic levels;
5. alcohol in any form;
6. drugs that may produce pain;
7. drugs known to produce adverse reactions or side effects, or capable of producing birth deformities.

•Experimental treatments shall not include electric shock, exercise until exhaustion, or other distressing stimuli.

•Behavioural studies shall use only reward (positive reinforcement) and no punishment in training programs.

•Food shall be palatable and of sufficient quantity and balance to maintain a good standard of nutrition. Animals shall not be allowed to go below the maintenance level of nutrition. *Clean drinking water shall be available at all times.* Containers for food and water must be of a design made specifically for that purpose.

•If egg embryos are subjected to experimental manipulations, the embryos must be destroyed humanely two days prior to hatching. If normal egg embryos are to be hatched, satisfactory humane considerations must be made for the disposal of the young birds.

•All experiments shall be carried out under the supervision of a competent environmental science teacher. It shall be the responsibility of the teacher to ensure that students have the necessary understanding for the study to be undertaken.

•All experimental animals used in teaching programs must be properly cared for. Animal quarters shall be made comfortable by providing for sanitation, protection from the elements, and space for exercise.. The living quarters shall have surfaces that may be easily cleaned, good ventilation and lighting, well-regulated temperatures, and cages of sufficient size to prevent overcrowding. Students must not be allowed to take animals home to carry out experimental studies. All studies involving animals must be carried out in a suitable area in the school. Animals must be protected from direct sunlight or other environmental factors that may disturb the well-being of the animal.

•Colonies and animal quarters shall be supervised by a teacher experienced in animal care. The students and other animal care staff shall be trained and required to handle the animals gently and humanely.

•The use of animals must comply with existing local, provincial, or federal legislation.

•All animals must be disposed of in a humane manner. If euthanasia has to be carried out, an approved method must be used and carried out by an adult experienced in such techniques.

- The procurement and use of animals and birds must comply with the Migratory Birds Convention Act of Canada and the Endangered Species Act of Canada, as well as any existing provincial legislation concerned with wild animals and exotic species.

Information on the care and housing of individual species may be obtained from "The Care of Experimental Animals: A Guide for Canada", available from the Canadian Council on Animal Care, 151 Slater Street, Suite 1105, Ottawa, Ontario, K1P 5H3.

Animal Care on Field Trips

The foregoing guiding principles also apply to the study of animals on field trips. In addition, the following guidelines should be observed:

- Animals that are collected for identification and study should be promptly returned to their habitats.
- Vertebrates should not be transported back to the classroom.
- Invertebrates that are collected for study in the classroom should be provided with environmental conditions which ensure that they suffer no harm during transportation and during their stay in the classroom. These animals should be returned to their habitats after classroom investigations are completed.
- Fish should not be handled by students, since handling by untrained persons removes the mucous coating that protects the fish from bacterial and fungal infection.
- Disturbance of animal habitats should be minimized. Many animals suffer and die because of thoughtless destruction of their habitats during field trips.

Animal Experimentation in Science Fairs

Biological experimentation is essential for an understanding of living processes. Such studies should lead to a respect for all living things. Capable students anxious to pursue a career in biological sciences must receive the necessary encouragement and direction. *All aspects of a project must be within the comprehension and capabilities of the student undertaking the study.*

Lower orders, such as bacteria, fungi, protozoa, and insects, can reveal much basic biological information. If experiments are to be conducted on living subjects for science fair projects, only lower orders of life may be used.

Vertebrate animals are not to be used in experiments for projects for science fairs, with the following exceptions:

- observations of the normal living patterns of wild animals in the free living state or in zoological parks, gardens, or aquaria;
- observations of the normal living patterns of pets, fish, or domestic animals. No living animal shall be displayed in exhibits in science fairs.

Cells such as red blood cells, other tissue cells, plasma, or serum purchased or acquired from biological supply houses or research facilities may be used in science fair projects. Observational studies on chicken egg embryos may also be used in science fair projects. If normal egg embryos are to be hatched, satisfactory humane considerations must be made for the disposal of the chicks. If such arrangements cannot be made, then the chicken embryos must be destroyed on the nineteenth day of incubation. No eggs capable of hatching may be exhibited in science fairs.

All experiments shall be carried out under the supervision of a competent environmental science teacher. It shall be the responsibility of this teacher to ensure that students have the necessary understanding for the study to be undertaken. Whenever possible, specifically qualified experts in the field shall be consulted. For information and the names of qualified experts write to:

Canadian Council on Animal Care
151 Slater Street, Suite 1105
Ottawa, (Ontario) K1P 5H3

Youth Science Foundation
Animal Care Committee
151 Slater Street, Suite 302
Ottawa, (Ontario) K1P 5H3

Suggestions Regarding Experiments Involving Animals

The following acceptable areas of animal experimentation at the pre-university level are offered to give guidance to youth science fair participants, environmental science teachers, and science fair directors.

•*Physiology*. Measure the normal physiological parameters, such as the respiratory rate, heart rate, temperature, quantity of food eaten, and the length of time dye-markers take to pass through the gastrointestinal tract and appear in the feces. Fecal output and urine production can be measured. As well, the amount of water supplied by a diet of greens can be compared to the amount of water an animal will normally imbibe, when the greens are used instead of the water.

•*Reproductive biology*. This may be studied with mice, hamsters, gerbils, or rats. The species may be observed under a variety of conditions. Studies may be repeated on the same animals because of the short gestation period. The animals may be treated in the following ways or modification of these ways:

1. Before breeding, a group of animals is gently handled and given kind treatment by the student each day,. After breeding, the gentle handling continues.
2. A second group of animals does not receive this gentle treatment, but is left to breed in the cages.
3. Two groups of animals are placed in a darkened room and not allowed any light, one group is removed each day and handled and the other group is not.

Many variations of this kind may be carried out without causing any distress to the animal. The number of the young-born is observed and recorded. In the same way, the number of young that are weaned is observed. In addition, the study can also involve the habits of the animals with respect to such factors as the provision of proper bedding materials or nest boxes.

•*Maze studies*. Students may wish to discover factors that might definitely lengthen or shorten the time it takes for an animal to journey through a maze. Will it make any difference to vary the amount of gentle handling or to vary the type of environment in which the animal lives (modified as to darkness or light, soft music or rock music, cool at 18°C or warm at 28°C and so on)? Only positive reinforcement should be used; negative influences such as electric shock, food deprivation, drastic temperature extremes, or painful prodding must not be permitted. With respect to temperature, variations within three to six degrees Celsius below or above the recommended normal maintenance temperature for the animal should not be exceeded. For example, if the normal temperature for a rat is considered to be 22°C, it is not recommended that the effects of temperature below 18°C or above 28°C be studied.

- *Environmental studies.* Again, light, darkness, and temperature may be considered in relation to gains in mass, to food intake, or to urinary output in young animals. The animals can be maintained in the darkness, handled or not handled, and then be brought into the light and handled regularly. Temperature variations should not exceed those mentioned under maze studies. Increase or decrease in mass can be observed under each variable.

- *Nutritional studies.* Again, *none* of these studies should involve the production of deficiencies or disease in animals. However, many studies can be carried out in which animals eat a balanced diet in different forms: for example, one group may be given food in a cube state (recognizing that most rodents are gnawers), another group may be fed on a powdered ration or a meal mixture, and a third group may be given food that is moistened with water. The animals used should be in the growing stage. They should be weighed each day, and such measurements as gains in body mass recorded. In this way, students learn to handle the animals and to make reliable measurements. In such studies, fecal and urinary output are other possible variables that can be measured.

- *Behavioural studies.* The effect of enriched environments (as compared with environments in which only the necessities, such as food and water, are provided) on the behaviour of animals may be studied. Students may let their imaginations free to create such environments: such environments can utilize bright or dull colours, round or square objects, and so on. Many psychology departments conduct studies in which behavioural scientists look at the effects of enriching an environment. This has a positive application to contemporary problems of human sociology.

- *Anatomical preparations.* The bodies of dead animals may be obtained from humane societies or research laboratories where animals have been killed humanely. The preparation of skeletons from these animals by cleaning the bones and restructuring the body is a giant task. A comparison of the various bones in animals is another interesting study, particularly if the function of the bones is also considered.

- *Genetics.* Various colours of mice, rats, hamsters, or rabbits may be bred and the colour adaptations recorded. Similarly, one can study the effects of random breeding, brother and sister matings, and line breeding with respect to the number of young born, their colours, sex, and so on.

- *Field studies.* Data can be collected concerning the numbers of wild animals within a given area, for example, the woodpecker population in an area close to an industrialized or built-up area and one far removed. There are many studies that can be developed to determine the effects on animals of the various combinations of changes in the environment that humans have produced. Students can also build feeding stations and study bird populations or animal populations as they arise. An observation of animals in a dump is a worth-while project.

- *Study of the senses.* In studies based on sight, smell, and taste, only those things with which we may daily come into contact should be considered. Various studies can be done in which the behaviour of animals can be observed when they are exposed to various colours in their environment or to such strong odours as peppermint or onion. Ordinary food stuffs that are fed to laboratory animals can be coloured with vegetable dyes or altered with respect to taste by the addition of spices. Nothing should be added to the food that would be regarded as unacceptable to human senses.

APPENDIX C: PREPARATION OF AN ATTITUDE-BEHAVIOUR QUESTIONNAIRE

The intent of a questionnaire of this type is to collect information on an environmental issue for use in class discussions of the issue. Selected students could be asked to help prepare the questionnaire. However, the entire class should assist with the administration of the questionnaire and with the analysis of the results. The following ideas should help with the design of an efficient and effective questionnaire.

1. Keep it short, well-organized and neat.
2. Progress logically from items that solicit general information to those that solicit more specific information. Place emotional items near the end. Thus the questionnaire could begin with items that collect information on the respondent that may have a bearing on his/her attitude and behaviour - age, sex, highest level of education, occupation, and so on. George Gallup's quintadimensional plan of question design may be used for the remaining items:
    a) Start with items that are designed to find out whether the respondent is aware of or has thought about the issue at all.
    b) Add some items that solicit the respondent's general feelings about the issue.
    c) Add some items that deal with specific parts of the issue.
    d) Include some items to discover reasons for the respondent's views.
    e) Find out how strongly such views are held.
3. In general, use items that can be answered by placing a tick mark in a given box. Such responses are much easier to analyze than are written responses.
4. Items that solicit opinions and emotional reactions often yield more useful data if you provide several options for the response instead of merely a "yes-no" response. Five options are usually enough:

☐	☐	☐	☐	☐
Strongly agree	Agree	Disagree	Strongly disagree	No opinion

5. The questionnaire should show no bias, when possible.
6. A few distractors dispersed throughout the questionnaire will likely increase the validity of the results. However, the distractors must not be nonsense items; they must appear, to the respondent, to be related to the issue.
7. Leave a few lines at the end of the questionnaire for "Your Comments".

Important Notes

1. Inform the students that they must make it clear to *all* people whom they ask to complete a questionnaire that participation is voluntary.
2. Avoid invasion of privacy. Information relating to income, education, and other personal factors may be important in the study. However, the respondent should be offered a "decline" option in the questionnaire.

A Sample Questionnaire

THE AUTOMOBILE IN OUR SOCIETY

Please complete this questionnaire by checking the appropriate box. Participation is voluntary.

1. SEX: Female ☐ Male ☐

2. AGE: Younger than 16 ☐ 16-20 ☐ 21-30 ☐ 31-50 ☐ Over 50 ☐ Decline ☐

3. RESIDENCE: City ☐ Suburb ☐ Town ☐ Rural ☐

4. GROSS FAMILY INCOME: less than $5000 ☐ $5-10 000 ☐ $10-20 000 ☐ $20-30 000 ☐ Over $30 000 ☐

5. Number of persons in our household is ____, of which ____ has (have) a driver's license. Decline ☐

6. The number of cars in our household is 1 ☐ 2 ☐ 3 ☐ 4 ☐

7. The car(s) would be classified as: (give numbers of each if more than 1)
   Full Size ☐
   Mid-Size ☐
   Compact ☐
   Sub-Compact ☐

8. I drive to work/school. Yes ☐ No ☐ Sometimes ☐ Not applicable ☐

	Adequate	Too High	Too Low
9. A) Present speed limits on city streets are:	☐	☐	☐
B) Present speed limits on highways are:	☐	☐	☐

	Always	Usually	Occasionally	Seldom	Never
10. I limit the use of the car as much as possible.	☐	☐	☐	☐	☐
11. I drive within the speed limit.	☐	☐	☐	☐	☐
12. Seeing people driving alone in big cars upsets me.	☐	☐	☐	☐	☐
13. Drivers that make jackrabbit starts in their cars upset me.	☐	☐	☐	☐	☐

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	NO OPINION
14. There is no shortage of fossil fuels (i.e. gasoline).	☐	☐	☐	☐	☐
15. Luxuries such as air conditioners which increase fuel consumption should be banned.	☐	☐	☐	☐	☐
16. Trunk space should be drastically cut since it is seldom used.	☐	☐	☐	☐	☐
17. Car size should be limited to 4 occupants.	☐	☐	☐	☐	☐
18. Good fuel economy is a very important criterion when I buy a car.	☐	☐	☐	☐	☐
19. Fuel should be rationed.	☐	☐	☐	☐	☐
20. Driving a car in the downtown core should be banned.	☐	☐	☐	☐	☐
21. A car should have at least 3 occupants before it is allowed on designated roads during peak travel times such as rush hour traffic.	☐	☐	☐	☐	☐
22. Emission control measures on cars should be tightened.	☐	☐	☐	☐	☐
23. Large engines are unnecessary since speed limits are so low.	☐	☐	☐	☐	☐
24. A car should be large enough to carry all members of the family.	☐	☐	☐	☐	☐
25. I'm willing to pay the extra cost of fuel so I can drive a big car that's comfortable on long trips.	☐	☐	☐	☐	☐

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	NO OPINION
26. The electric car or some other form of energy will be utilized in the future, so there is no cause for concern about fuel shortages today.	☐	☐	☐	☐	☐
27. The type of car I drive is nobody's business but my own.	☐	☐	☐	☐	☐
28. The "Energy Crisis" was made up by the government and big business to allow them to increase fuel prices; and in fact, there is no shortage of fuel.	☐	☐	☐	☐	☐
29. The government should pass further laws to:					
A) Reduce the size of cars.	☐	☐	☐	☐	☐
B) Increase the fuel economy of cars.	☐	☐	☐	☐	☐
C) Restrict the use of cars.	☐	☐	☐	☐	☐
30. Why should I show restraint when few others do?	☐	☐	☐	☐	☐
31. If bad times are coming I'm going to enjoy a big car and lots of travelling while I can.	☐	☐	☐	☐	☐
32. The increase in fuel prices is no different from the increase in the cost of food, clothes and housing costs: It's a sign of the times.	☐	☐	☐	☐	☐

COMMENTS:

Thank you for your efforts in completing this questionnaire.

APPENDIX D: BIBLIOGRAPHY

The following entries provide information on books and periodicals that will be of assistance to teachers as they develop curriculum for Environmental Science and Agriculture. In general, the entries represent materials suitable for teacher use and are not chosen as student references.

BOOKS

Alex, J.F. and C.M. Switzer. *Ontario Weeds.* Guelph: Ontario Ministry of Agriculture and Food (Publication 505).

This book gives descriptions and illustrations of Ontario weeds and keys to their identification.

Andrews, W. A., and J. L. Cranmer-Byng (eds.). *Urban Natural Areas: Ecology and Preservation.* Toronto: Institute for Environmental Studies, University of Toronto, 1981.

This book provides the content and methodology for the study of urban natural areas from scientific, social, political, and legal perspectives.

Bird, J. Brian. *The Natural Landscapes of Canada.* 2nd ed. Toronto: John Wiley & Sons Canada Limited, 1980.

Through a discussion of geological history, glaciation, and major physiographic regions of Canada, this book provides a basic understanding of the landscapes of Canada.

Bold, Harold C. *The Plant Kingdom.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1977.

This book gives an orderly presentation of basic facts regarding the taxonomy and reproduction of representative members of the plant kingdom.

Bold, Harold C. and Michael J. Wynne. *Introduction to the Algae.* Englewood Cliffs: Prentice-Hall, Inc., 1978.

This comprehensive text is an excellent reference for information on the taxonomy, morphology, physiology, and cultivation of algae.

Brock, Thomas D. and Katherine M. Brock. *Basic Microbiology.* 2nd ed. Englewood Cliffs: Prentice-Hall, Inc., 1978.

This introductory text deals primarily with those aspects of microbiology that directly affect human affairs, such as public health, environmental protection, agriculture, and food technology.

Bundy, Clarence E., Ronald V. Diggins and Virgil Christensen. *Livestock and Poultry Production.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1975.

This text provides information on the production, management, and marketing of swine, beef, horses, dairy cattle, sheep, and poultry.

Bundy, Clarence E., Ronald V. Diggins and Virgil W. Christensen. *Swine Production.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1976

Breeding, feeding, housing, disease treatment and marketing are among the topics covered in this text.

Davidson, Harold and Roy A. Mecklenburg. *Nursery Management.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

This book covers the various types of nursery businesses and the operations and decisions essential to their management.

Delorit, Richard J., Louis J. Greub and Henry L. Ahlgren. *Crop Production.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1974.

Before exploring crop production, this text covers basic plant information such as parts, growth and reproduction. Current information on pesticides is included.

Diggins, Ronald V., Clarence E. Bundy and Virgil W. Christensen. *Dairy Production.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1979.

This text includes information on artificial insemination, loose housing, feeding, and the importance of dairy products in human nutrition.

Donahue, Roy L., James E. Christiansen and Everett F. Evans. *Exploring Agriculture.* 5th ed. Englewood Cliffs: Prentice-Hall, Inc., 1979.

This book stresses the practice of agriculture and food production including farm management and career opportunities, environmental protection, and new crop and livestock production guidelines.

Donahue, Roy L., Raymond W. Miller and John C. Schikluna. *Soils: An Introduction to Soils and Plant Growth.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1977.

This secondary school text describes all aspects of soil science and its application to plant growth.

Donaldson, R.M. *A Canadian's Urban Environment.* Toronto: Butterworth and Co. Ltd., 1975.

This book provides comprehensive coverage of the urban environment, including land uses and urban problems.

Energy Probe. *Energy Sources for Today.* Toronto: Tutor Press, 1978.

This book provides an understanding of renewable energy sources and conversion technologies.

Estrin, David and John Swaigen. *Environment on Trial.* Rev. ed. Toronto: Canadian Environmental Law Research Foundation, 1978.

This book presents a detailed treatment of environmental law for use by citizens.

Flocker, William J. and Hudson T. Hartmann. *Plant Science: Growth, Development, and Utilization of Cultivated Plants.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

This text provides information on how the major food, forage, and fibre crops are produced.

Follett, Roy Hunter, Larry Murphy and Roy Donahue. *Fertilizers, Soil Amendments and Plant Nutrition.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

This introduction to modern fertilizer technology discusses essential elements, their roles in plant nutrition, the soil chemistry of the elements, fertilizer sources, and methods of application.

Frankton, Clarence and Gerald A. Mulligan. *Weeds of Canada.* Ottawa: Information Canada, 1970.

This book provides descriptions, diagrams, and information on origin, distribution, and habitats for common weeds.

Greenwood, N.J. and J.M.B. Edwards. *Human Environments and Natural Systems.* 2nd ed. North Scituate, Mass.: Duxbury Press, 1979.

This book begins with a description of the confrontation between humans and the natural world and then proceeds to treat environmental problems such as energy, food, pollution of water and air, solid wastes, toxic substances, radiation, urban problems, wilderness preservation, and land use.

Greisel, Irma and Peter Jensch. *Investigating Our Ecosystem.* Markham, Ont.: Houghton Mifflin Company, 1976.

Field and laboratory activities are integrated with brief narratives in this book which surveys terrestrial and aquatic ecosystems.

Hare, F. Kenneth and Morley K. Thomas. *Climate Canada.* 2nd ed. Toronto: John Wiley & Sons Canada Limited, 1979.

This book presents a descriptive account of Canada's climates and their interactions with humans. It is designed to assist geographers, biologists, soil scientists, and hydrologists with the problems of environmental management.

Harsh, Stephen, Larry Connor and Gerald Schwab. *Managing Farm Business.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

This book explores management concepts and principles as applied to the farm business. Emphasis is given to record systems, planning techniques, tax management, investment analysis and risk analysis.

Hartmann, Hudson T., William J. Flocker and Anton M. Kofranek. *Plant Science: Growth, Development and Utilization of Cultivated Plants.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

Written for introductory agronomy or crop science courses, this text presents the fundamentals of plant science with a practical approach.

Hosie, R.C. *Native Trees of Canada.* 8th ed. Toronto: Fitzhenry and Whiteside, 1979.

This book is the best source for the identification of our native trees.

Hotchkiss, Neil. *Common Marsh, Underwater & Floating-leafed Plants of the United States and Canada.* New York: Dover Publications, Inc., 1972.

This book is an easy-to-use guide to the identification of aquatic plants.

House of Commons. *Still Waters: The Chilling Reality of Acid Rain.* Ottawa: Ministry of Supply and Services, Canada, 1981.

This document is a report by the subcommittee on acid rain of the Standing Committee on Fisheries and Forestry of the House of Commons.

Howard, Ross. *Poisons in Public.* Toronto: James Lorimer and Company, 1980.

This book explores four serious and representative instances of pollution affecting Canadians.

Howard, Ross and Michael Perley. *Acid Rain.* Toronto: House of Anansi Press, Ltd., 1980.

This book discusses the sources and ecological effects of acid precipitation in Ontario.

Jones, Robert M. (series ed.) *The Time-Life Encyclopaedia of Gardening.* New York: Time-Life Books, 1970s.

This series of 30 books would be an excellent classroom reference set for horticulture and landscaping units of study; covers indoor, outdoor and greenhouse gardening, pest control, plant selection and husbandry, landscaping, lawns, trees and shrubs, and many other areas.

Kaplan, Stephen and Rachel Kaplan (eds). *Humanscape: Environments for People.* North Scituate, Mass.: Duxbury Press, 1978.

This book applies the skills and insights of the behavioural sciences to develop an understanding of what people are like and, as a result, further our understanding of the social/environmental problems that surround us.

Knute, Leo L., David L. Williams and J.S. Hide. *Profitable Soil Management.* 3rd ed. Englewood Cliffs: Prentice-Hall, Inc., 1979.

This is a basic text in soil science and soil management for secondary school students; covers soil characteristics, plant growth and nutrition, irrigation, soil fertility and fertilization, and tillage.

Kormondy, Edward J. *Concepts of Ecology.* 2nd ed. Englewood Cliffs: Prentice-Hall, Inc., 1976.

This small but thorough book is a useful source of information on the basic principles of ecology and their applications.

Lang, Reg and Audrey Armour. *Environmental Planning Resourcebook.* Montreal: Multiscience Publications, Ltd., 1980

This Canadian book provides the information base for the consideration of land use conflicts. It proposes an environmental approach to land planning.

Lasley, John F. *Genetics of Livestock Improvement.* 3rd ed. Englewood Cliffs: Prentice-Hall, Inc., 1978.

Written for use in Animal Science courses, this text provides comprehensive and current information on livestock genetics.

Lasley, John F. *Beef Cattle Production.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

This concise yet all-inclusive book presents the basic principles and applications of beef cattle production, including genetics, nutrition, feeds and feeding, marketing, and behaviour.

Livingston, John A. *One Cosmic Instant.* Toronto: McClelland and Stewart Ltd., 1973.

This book provides well-reasoned information that will assist the teacher in understanding and developing a positive environmental ethic.

Livingstone, John A. *The Fallacy of Wildlife Conservation.* Toronto: McClelland and Stewart, 1981.

This book provides well-reasoned information that will assist the teacher in understanding and developing a positive environmental ethic.

Maxwell, Kenneth E. *Environment of Life.* 3rd ed. Monterey, Calif.: Brooks/Cole Publishing Company, 1980.

The thrust of this text is to provide informative and authoritative information on ecological principles, human populations, genetics, environmental quality, energy, land use, wildlife, and conservation.

McBoyle, G.R. and E. Sommerville. *Canada's Natural Environment.* Toronto: Methuen, 1976.

This book deals with Canadian climate and weather, our hydrological resource base, soil and land management, and the future of our natural environment.

McCombs, Lawrence W. and Nicholas Rosa. *What's Ecology?* Don Mills, Ont.: Addison-Wesley Publishing Company, 1978.

This book offers an introductory treatment of basic ecological principles, major aquatic and terrestrial ecosystems, conservation, human population, and urban ecology.

Merritt, Richard W. and Kenneth W. Cummins (eds). *An Introduction to the Aquatic Insects of North America.* Dubuque, Iowa: Kendall/Hunt Publishing Company, 1978.

In addition to information on life cycles and morphology, this book provides well-illustrated keys for the identification of aquatic insects.

Miller, G. Tyler Jr. *Energy and Environment.* Belmont, Calif.: Wadsworth Publishing Company, 1980.

The two basic energy laws - you can't get something for nothing and you can't even break even - are used to evaluate our energy options.

Miller, G. Tyler Jr. *Living in the Environment.* Belmont, Calif: Wadsworth Publishing Company, 1982.

This respected text provides detailed discussions of basic ecology, population problems, agriculture, water and air pollution, politics, environmental ethics and many other key topics.

Nebel, Bernard J. *Environmental Science: the way the world works.* Englewood Cliffs: Prentice-Hall, Inc., 1981.

This text provides a detailed treatment of basic ecology, soils and agriculture, domestic wastes, industrial wastes, pest control, resources, land use, energy, and population.

Nelson, Wm. R. Jr. *Landscaping Your Home.* Rev. ed. Urbana-Champaign: University of Illinois at Urbana-Champaign, College of Agriculture, Cooperative Extension Service, Circular 1111, 1975.

This book is used as a text by many colleges for the teaching of the basic principles of landscape design.

Orlans, F. Barbara. *Animal Care From Protozoa to Small Mammals.* Don Mills, Ont.: Addison-Wesley Publishing Company, 1977.

This book offers a sound moral and ethical framework for the principles of animal care and describes procedures for the care of a wide variety of life forms.

Ontario Royal Commission on Electric Power Planning. *Our Energy Options.* Toronto: Government of Ontario, 1978.

Seven aspects of electric power planning are examined in this book by competent authorities: efficient utilization, environmental and health issues, alternative technologies, nuclear energy, fuels, bulk transmission, and socio-economic factors.

Pennak, Robert W. *Freshwater Invertebrates of the United States.* 2nd ed. Toronto: John Wiley and Sons, Inc., 1978.

One of the most authoritative and comprehensive texts on freshwater biology, this book provides keys, excellent diagrams, and information on the general characteristics. morphology, physiology, ecology, and distribution of freshwater invertebrates from protozoans to pelecypods.

Poincelot, Raymond P. *Horticulture: Principles and Applications.* Englewood Cliffs: Prentice-Hall, Inc., 1980.

This book gives a thorough introduction to both commercial and home horticulture.

Purdom, P. Walton and Stanley H. Anderson. *Environmental Science: Managing the the Environment.* Toronto: Charles E. Merrill Publishing Company, 1980.

This text first describes physical systems (geophysical, atmospheric and hydrological) and then proceeds to show how living processes interact with the physical systems. Energy, minerals, natural systems, human population, resource conservation and food are the major topics in the second section. The remainder of the book deals with water and air quality, solid wastes, radiation, pesticides, noise and urban living.

Rawlins, N. Omri. *Introduction to Agribusiness.* Englewood Cliffs: Prentice-Hall, Inc., 1980.

This text explores the definition and scope of agribusiness, and features a discussion of farm resources (feed, machinery and equipment, chemicals and credit) along with the marketing aspects.

Ridgeway, James. *Who Owns the Earth.* New York: MacMillan Publishing Co., Inc., 1980.

This penetrating book points out which countries control the world's resources, discusses the management of the resources, and describes the international intrigue behind the manipulation of resources.

Rowe, J.S. *Forest Regions of Canada.* Ottawa: Information Canada, 1972.

This book describes the abiotic and biotic features of the eight forest regions of Canada.

Stanier, Roger Y., Edward A. Adelberg and John L. Ingraham. *The Microbial World.* 4th ed. Englewood Cliffs: Prentice-Hall, Inc., 1976.

Written for microbiology majors, this text is an authoritative source for information on all aspects of microbiology.

Stobaugh, Robert and Daniel Yergin (eds). *Energy Future.* New York: Random House, 1979.

Produced at the Harvard Business School, this book uses a managerial mode of analysis that assesses priority and potential, cost and risk, incentive, profit, and the marketplace as it discusses energy options for the future.

Troeh, Frederick R., J. Arthur Hobbs and Roy L. Donahue. *Soil and Water Conservation for Productivity and Environmental Protection.* Englewood Cliffs: Prentice-Hall, Inc., 1980.

In addition to the topics suggested by the title, this book considers agricultural engineering, mining and other uses of land.

Turk, Amos, Jonathan Turk, Janet T. Wittes, and Robert Wittes. *Environmental Science.* Toronto: W.B. Saunders Company, 1978.

After establishing the basic principles of ecology, this book explores extinction of species, growth of human populations, energy, agricultural systems, control of pests and weeds, radioactive pollutants, air pollution, water pollution, solid wastes, noise, and the social, legal and economic aspects of environmental degradation.

Turk, Jonathan. *Introduction to Environmental Studies.* Toronto: W.B. Saunders Company, 1980.

This introductory text includes information on basic ecology, extinction of species, population problems, world resources, energy, nuclear problems, agriculture, pests, air pollution, water pollution, solid wastes, and noise.

UNESCO Occasional Paper 31. *UNESCO and Environmental Education.* Ottawa: Canadian Commission for UNESCO, 1978.

This document provides helpful information on the goals, objectives and guiding principles of environmental education.

Waldbott, George L. *Health effects of environmental pollutants.* Saint Louis: The C.V. Mosby Company, 1978.

This book gives a comprehensive, useful and readable account of the sources, nature and health effects of a wide variety of air and water pollutants.

Webb, Madelyn. *The Canadian Environment: Data Book on Energy and Environmental Problems.* Toronto: W.B. Saunders Company Canada Limited, 1980.

This book contains the data base essential for a full understanding of Canadian energy and environmental problems.

Webber, L.R. (ed.) *Ontario Soils.* Guelph: Ontario Ministry of Agriculture and Food (Publication 492.

This publication is an excellent source of information on physical, chemical and biological properties of soil, plant nutrients, soil management, manure use, waste water disposal and the use of wastes from sewage treatment plants.

York-Toronto Lung Association. *Environmental Health Hazards.* Willowdale: York-Toronto Lung Association, 157 Willowdale Ave., Willowdale, Ont. M2N 4Y7, 1980.

Pollutants in community air and pollutants in the indoor environment are the main topics of this book.

PERIODICALS

Alternatives. Traill College, Trent University, Peterborough, Ont. K9J 7B8.

Published by Friends of the Earth, Canada, this journal publishes scholarly articles on such topics as the conserver society, energy conservation, pollution, and sociological problems.

Audubon. National Audubon Society, 950 Third Avenue, New York, N.Y. 10022, U.S.A.

The articles in this journal range in scope from nature study to an in-depth examination of environmental problems.

Canadian Geographic. The Royal Canadian Geographical Society, 488 Wilbrod St., Ottawa, Ont., K1N 6M8.

This journal covers such diverse topics as the Alberta tar sands, arctic environments, tidal mud flats, wildlife habitats, the impact of snowmobiles, rangeland management, and Canada's climates.

Country Guide. Public Press, 150 Eglinton Ave. E., Toronto, Ont. M4P 1E8.

This journal carries regular columns on crops, hogs, dairy, beef, and country living, and features a wide variety of topics such as energy production from manure, biomass energy from corn, farm management, and land use conflicts.

Countryside. 312 Portland Rd., Waterloo, Wisconsin 53594, U.S.A.

Written especially for homesteaders, this journal reflects a very positive environmental ethic through its regular columns on sheep, cattle, hogs, gardening, goats, and rabbits, and through feature articles on such topics as soil erosion, equipment maintenance, water conservation, alternative energy sources, and woodlot management.

ESTAO Bulletin. Box 370, Beamsville District S.S., Beamsville, Ont., LOR 1B0.

This publication by the Environmental Science Teachers' Association of Ontario contains articles on the content and methodology of environmental science teaching.

Harrowsmith. Cambden House Publishing Ltd., Cambden East, Ont., K0K 1J0.

The articles in this journal range from wood stoves and plant and animal husbandry to nuclear energy, biomass energy sources, solar collectors and species extinction.

International Wildlife. National Wildlife Federation, 1412 16th St. NW., Washington, D.C. 20036, U.S.A.

International in scope, this journal deals with such topics as endangered species, habitat destruction, animal behaviour, and conservation.

The Journal of Environmental Education. Heldref Publications, Suite 500, 4000 Albermarle St. NW., Washington, D.C. 20016, U.S.A.

This journal is devoted to the reporting of recent research and practices in environmental education.

The Monograph. Ontario Association for Geographic and Environmental Education, Box 438, Postal Station "O", Toronto, Ont., M4A 2P1.

This journal of the Ontario Association for Geographic and Environmental Education publishes a wide selection of articles on the content and methodology of environmental education.

National Wildlife. National Wildlife Federation, 1412 16th St. NW., Washington, D.C. 20036, U.S.A.

This journal deals with the flora and fauna of North America, emphasizing conservation and environmental quality.

Nature Canada. Canadian Nature Federation, 75 Albert Street, Suite 203, Ottawa, Ontario, K1P 6G1.

This journal of the Canadian Nature Federation offers information on the flora and fauna of Canada and on environmental matters of national significance.

Organic Gardening. Rodale Press, Inc., Emmaus, Pennsylvania 18049, U.S.A.

This journal on organic gardening and farming provides countless ideas for horticulture, landscaping, and gardening units of study and, in addition, reflects a strong conserver society outlook.

Post Probe. Pollution Probe, 12 Madison Avenue, Toronto, Ont., M5R 2S1.

This well-known publication provides useful information on current problems and suggestions for citizen involvement in the solution of problems.

Seasons. Federation of Ontario Naturalists, 355 Lesmill Rd., Don Mills, Ont., M3B 2W8.

Published by the Federation of Ontario Naturalists, this journal provides useful information on the flora and fauna of Ontario as well as information on environmental issues such as the escarpment plan and provincial parks policy.

APPENDIX E: KEY TO RECOMMENDED RESOURCES

The first two parts of this appendix lists the addresses of the organizations that produced the resources listed in the "Activities and Resources" column of Part C of this document. The last part lists further sources of information.

SOURCES FOR FILMS AND FILMSTRIPS

A&B	Allyn and Bacon Canada Ltd., 791 St. Clair Ave. W., Toronto, Ont., M6C 1B8	
BPI	Bergwall Productions, Inc., 839 Stewart Ave., Garden City, New York 11530 U.S.A.	
CFI	Counsellor Films, Inc., Available from Marlin	Marlin Motion Pictures Ltd., 47 Lakeshore Rd. E., Mississauga, Ont., L5G 1C9
CREF	Canadian Renewable Energy Foundation Box 4902 Station "E" Ottawa, Ont., K1S 5J1	
EBE	Encyclopaedia Britannica Publications Ltd., Instructional Materials Division, 2 Bloor St. W., Toronto, Ont., M5W 3J1	
FFC	Film Fair Communications, Available from Marlin	
IFB	International Film Bureau, Inc., Available from Marlin	
LCA	Learning Corporation of America Available from Marlin	
MAC	Macmillan Films Inc., Available from Marlin	

MAF	Ontario Ministry of Agriculture and Food, Information Services Branch, 801 Bay St., Toronto, Ont., M7A 1A5
NFB	National Film Board of Canada, Mackenzie Building, 1 Lombard St., Toronto, Ont., M5C 1J6 NFB has branch offices in many cities across Ontario,
NG	National Geographic Society Educational Services, 151 Carlingview Dr., Unit No. 5, Rexdale, Ont., M9W 5E7
OFIA	Ontario Forest Industries Association, 130 Adelaide Street West, Toronto, Ont., M5H 3P5
PH	Prentice-Hall Media, 1370 Birchmount Rd., Scarborough, Ont., M1P 2J7
S&M	Science and Mankind, Inc., Communications Park, P. O. Box 2000, Mount Kisco, New York 10459 U.S.A.
SEF	Sterling Educational Films, Available from Marlin
SP	Schloat Productions Available from Marlin
TL	Time-Life Films, Available from Marlin
UN	United Nations Available from Marlin

VEC Visual Education Centre,
75 Horner Ave., Unit One,
Toronto, Ont.,
M8Z 4X5

VEP Vocational Education Productions,
California Polytechnic State University,
San Luis Obispo, California 93407
U.S.A.

SOURCES FOR RECOMMENDED PRINTED MATERIALS

Environment Canada,
Information Services Directorate,
Ottawa, Ont.,
K1A 0H3

Energy, Mines, and Resources Canada,
580 Booth St.,
Ottawa, Ont.,
K1A 0E4

HM Houghton Mifflin Canada Limited,
150 Steelcase Rd. W.,
Markham, Ont.,
L3R 1B2

Ontario Government Bookstore,
880 Bay Street,
Toronto, Ont.,
M7A 1N8

Ontario Institute of Agrologists,
Room 451,
University Centre,
University of Guelph,
Guelph, Ont.

Ontario Ministry of Agriculture and Food,
Information Services Branch,
801 Bay Street,
Toronto, Ont.,
M7A 1A5

Ontario Ministry of Education,
Mowat Block,
Queen's Park,
Toronto, Ont.,
M7A 1L2

Ontario Ministry of Energy,
56 Wellesley St. W.,
Toronto, Ont.,
M7A 2B7

Ontario Ministry of the Environment,
Information Services Branch,
4th Floor,
135 St. Clair Ave. W.,
Toronto, Ont.,
M4V 1P5

Ontario Ministry of Natural Resources,
Whitney Block,
Queen's Park,
Toronto, Ont.,
M7A 1L2

Royal Commission on the Northern Environment (Ontario),
55 Bloor St. W., Suite 801,
Toronto, Ont.,
M4W 1A5

Science Council of Canada Publications,

available from:

Printing and Publishing,
Supply and Services Canada,
Ottawa, Ont.,
K1A 0S9

OTHER SOURCES OF INFORMATION

There are many other governmental ministries and public organizations that have films, filmstrips, publications and other resources that will be helpful to the environmental science teacher. Among these are Ontario Hydro, the Ontario Ministry of Natural Resources, the Ontario Forestry Association, the Ontario Federation of Anglers and Hunters, Pollution Probe and the Conservation Council of Ontario. The addresses and concerns of these and other groups can be obtained from "Canadian Conservation Directory", Canadian Nature Federation, 46 Elgin Street, Ottawa, Canada, K1P 5K6.

A listing of government materials relating to environmental education can be obtained from:

Catalogue of Environmental Education Materials, Canada, 1979,
Ministry of Supply and Services,
Catalogue Number EN 21-31/1979
Ottawa, Ont.

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